FLOOD PLAIN MANAGEMENT STUDY
DELTA JUNCTION, ALASKA

prepared by

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

in cooperation with

CITY OF DELTA JUNCTION
and
SALCHA-BIG DELTA SOIL CONSERVATION DISTRICT

NOVEMBER 1987

FOREWORD

The flood and erosion hazard information in this report will provide the City of Delta Junction and other local governmental and planning agencies with the basis to formulate flood plain, land-use and management programs, adopt regulations, and inform the public of flood hazards and the options to control flood and erosion damage along the Delta River and Jarvis Creek in the vicinity of Delta Junction.

This study was made at the detailed intensity level. It is part of an overall low intensity Flood Plain Management Study (FPMS) being completed for portions of the Tanana Basin. Already published are "FPMS - Lower Tanana River and Tributaries" (SCS, May 1983), and "FPMS - Upper Tanana River and Tributaries" (SCS, September 1984).

The City of Delta Junction and the Salcha-Big Delta Soil and Water Conservation District assisted in providing land use data, obtaining permission for field surveys, and making other resource information available for use in the study. The City of Delta Junction provided nearly half the cost of making field investigations and the corresponding report. The SCS provided the remaining funds. The City will also help distribute the report and assist users to interpret study data, ensuring that the data can be used effectively in local flood plain management programs. The City, Salcha-Big Delta Soil and Water Conservation District, and Soil Conservation Service encourage the immediate use of the flood plain management information in implementing local programs, and upon request will assist in interpretation and use of data presented in this report.

The cooperation of other federal, state, and local agencies, property owners and local businesses in the collection of data for this report is appreciated.

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INTRODUCTION

Local Study Needs

The City of Delta Junction, as the result of receiving a grant from the Alaska Department of Community and Regional Affairs, requested that the U.S. Soil Conservation Service (SCS), through the Salcha-Big Delta Soil and Water Conservation District (District or SWCD) and Alaska Department of Natural Resources, carry out flood and erosion studies of Delta River and Jarvis Creek in the immediate vicinity of Delta Junction. In 1982, the City requested a legislative appropriation from the State to control bank erosion along the Delta River. The request was approved in the spring of 1983. Currently funding for Jarvis Creek flood control is being sought by the City, Deltana Community Corporation, and the SWCD.

This report provides a technical, economic, and environmental evaluation of measures proposed herein for controlling Delta River stream bank erosion and Jarvis Creek overflow flooding within the study area.

The citizens of Delta Junction believe that previous studies adequately discuss the problems caused by the Delta River. However, few existing reports consider the specific problems or situations detailed herein. A 1978 SCS flood hazard study identified flood prone areas in the vicinity of Delta Junction. An earlier SCS report (1975) identified the area flooded by Jarvis Creek. Neither of these (or any other report) addresses streambank erosion along the Delta River nor offers solutions to flooding problems caused by overflow from Jarvis Creek.

Study Location

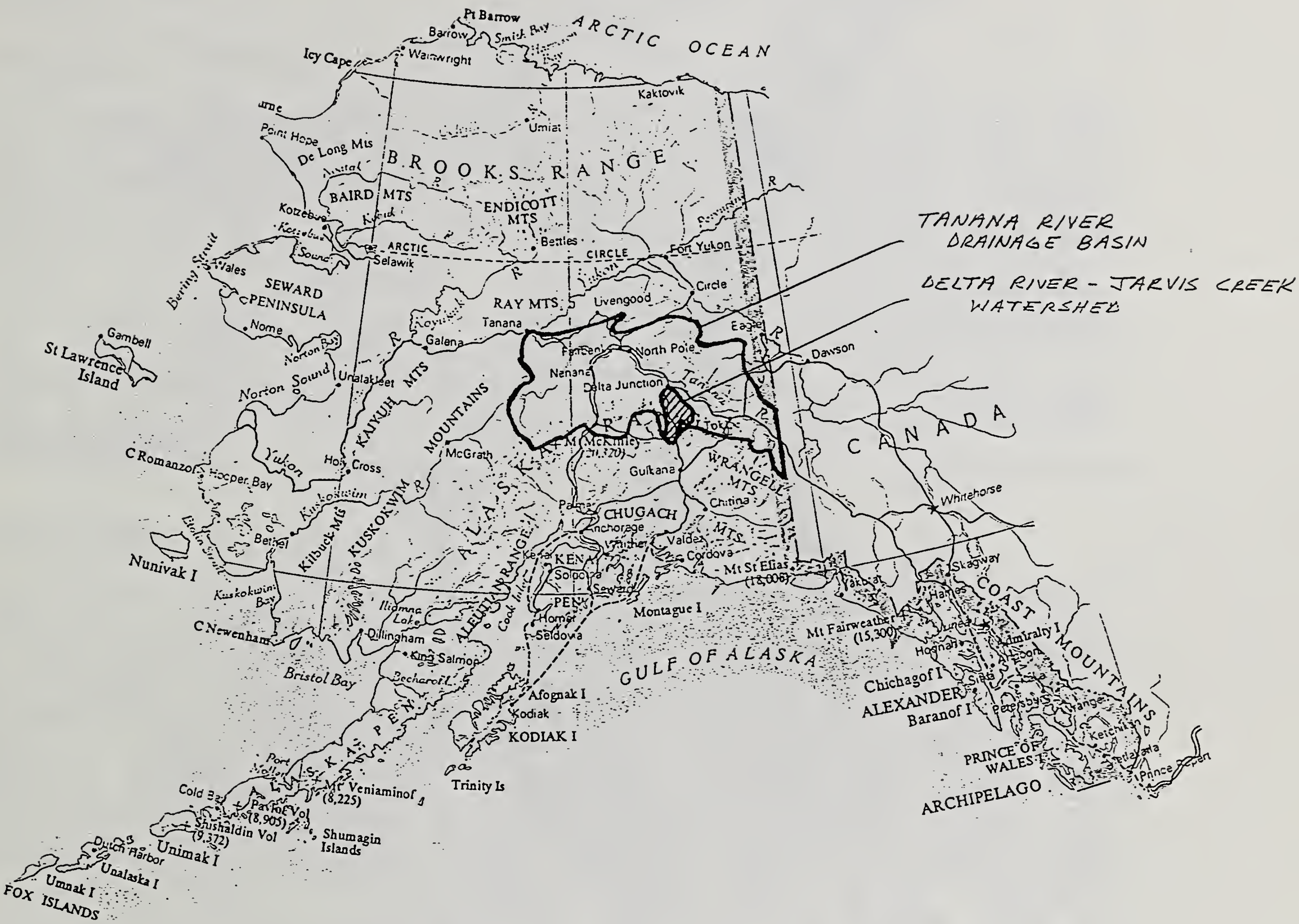
Figure 1 is a map of Alaska showing the Tanana River drainage basin and its contributing Delta River - Jarvis Creek subbasin. Figure 2 is a map of the Delta Junction area showing study area locations.

Specifically, the Delta River project area includes approximately one and a half miles of river bank, from the Richardson Highway bridge over Jarvis Creek northward to existing dikes near the Delta Junction city center. The Jarvis Creek project area includes approximately four miles of creek bank, land adjacent to the creek, and land to the north which is affected by flooding.

Study Authorities

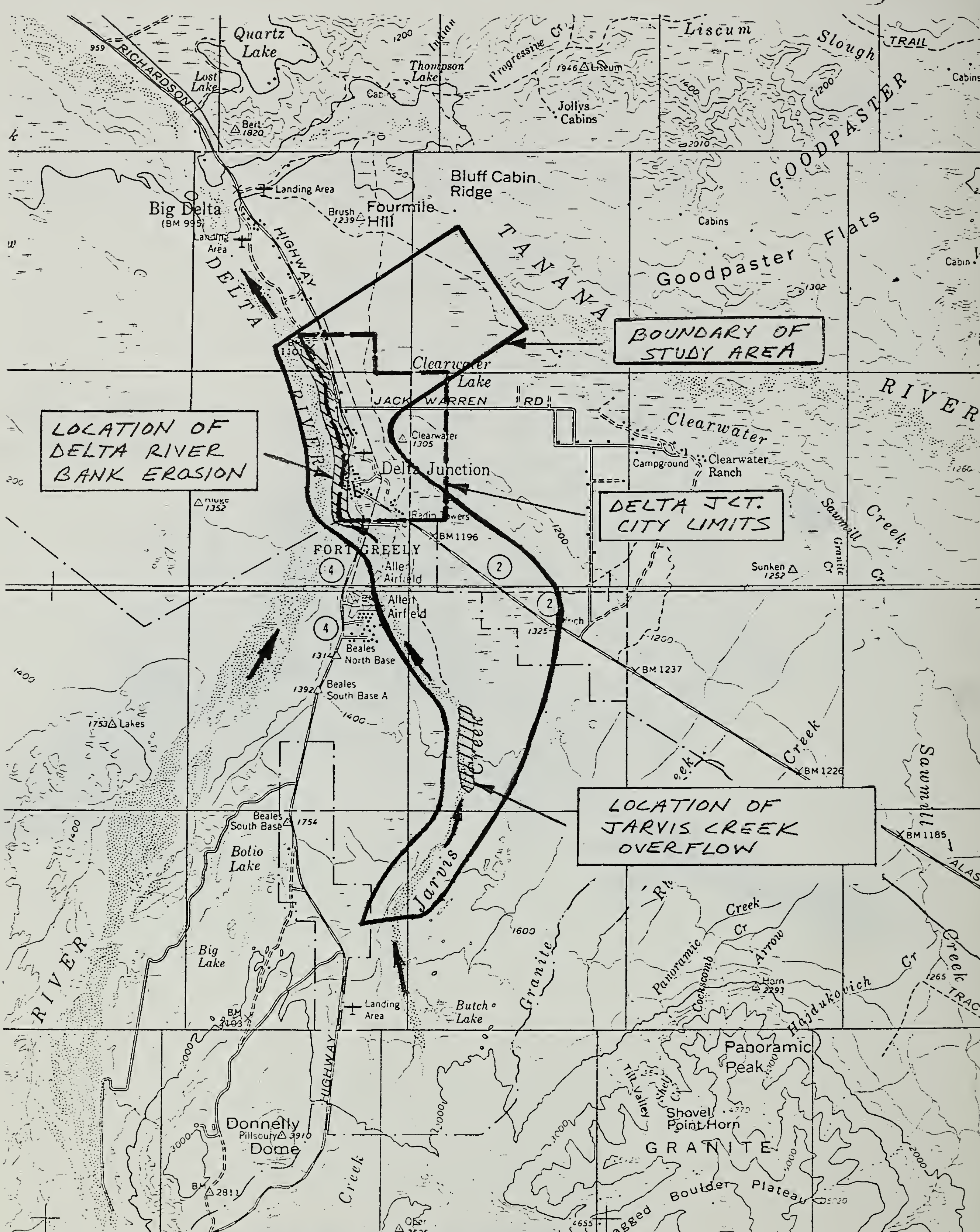
It was concluded in a public meeting held in 1983 that Delta River erosion and Jarvis Creek flooding were the City's top resource management priorities. The July 1984 Cooperative Agreement between the City and SCS established that the SCS would perform a study to evaluate these two problems and their alternative solutions. A Supplemental Plan of Work (supplemental to the State's 1982 Plan of Work for the Tanana Basin) was developed immediately thereafter.

Authority for SCS participation in this and other flood plain management investigations is provided by Section 6 of Public Law 83-566, the Watershed Protection and Flood Prevention Act of 1954. The SCS carries out such studies in accordance with Executive Order 11988 (dated May 24, 1977) and recommendation 9(c) of House Document Number 465, 89th Congress. The State's authority is outlined in AO 46 of Alaska State Laws.



LOCATION MAP

FIGURE 1



LOCATION OF STUDY AREA

FIGURE 2

FLOOD AND EROSION HISTORY

Overview

Extent of 100-year frequency flooding for Delta River and Jarvis Creek, and the Jarvis Creek overflow route, are shown in Figure 3, "Area Inundated By 100-year Flood".

Delta River

No historical records exist of Delta River flooding in or near the study area. Although flooding has not occurred in recent history, heavy late summer flows from melting glaciers result in severe bank erosion. Rates of erosion inside the city limits have been noted over the past 20 years. Figure 4 shows the location of river bank in several years during this period. Up to 300 feet of bank has been lost in some areas since 1951, an erosion rate of 10 feet per year. Local residents claim that most of this loss occurred during the past 15 years, yielding a rate of 20 feet per year. Delta River bank erosion has been described in further detail in several previous studies, including: Flood Hazard Analyses Delta Study Area, Alaska (SCS 1978) and Flood History of the Delta Junction Area (Yarborough 1975).

Jarvis Creek

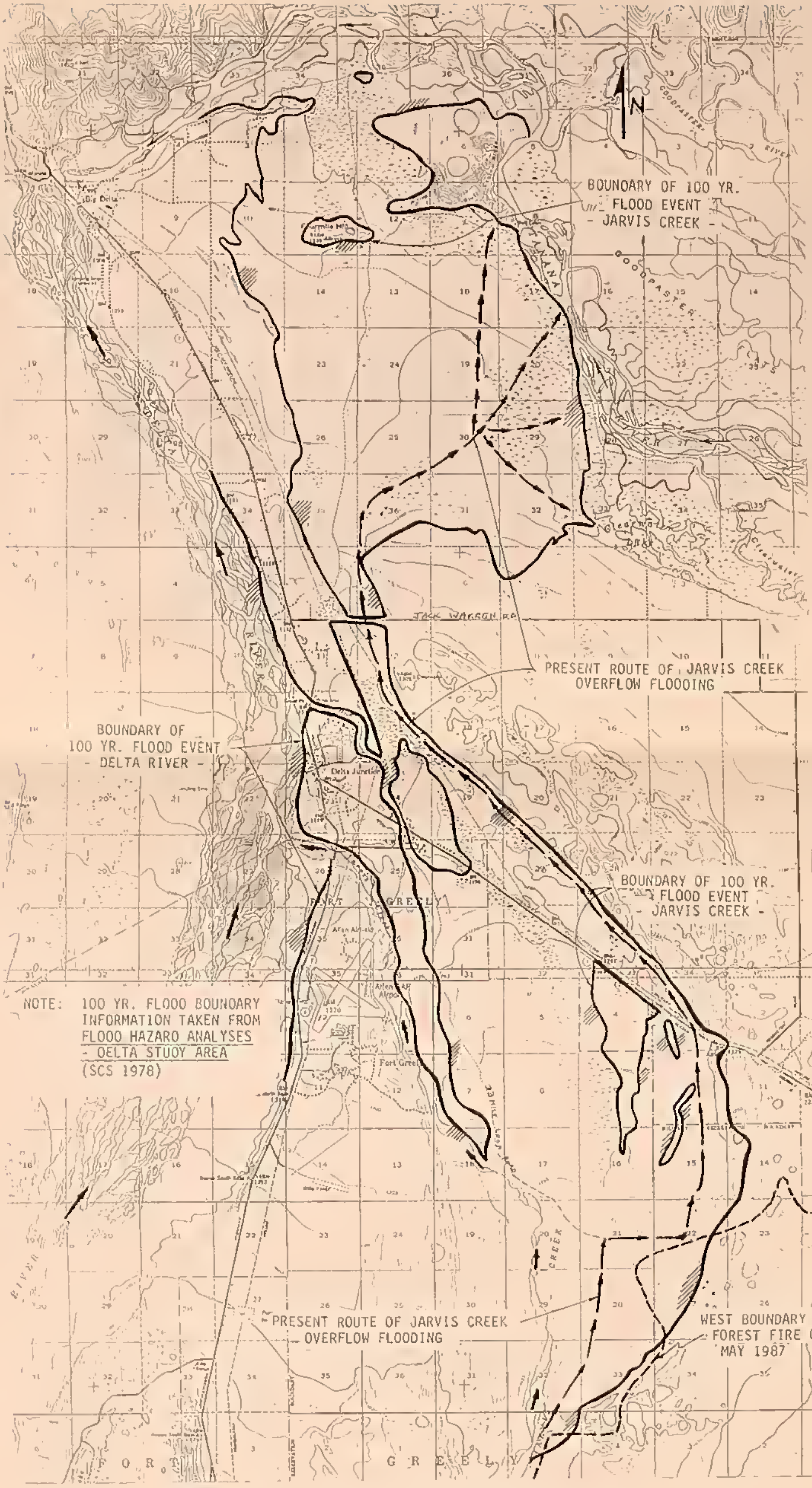
Jarvis Creek presents a different problem. Each spring, flooding occurs along all or a portion of a 20-mile overflow path. Flooding is triggered by aufeis which has formed over the winter in the creek bed. As spring runoff enters the channel it flows downstream to the north until reaching the aufeis "dam." At this point, flows are forced out of the east bank of Jarvis Creek along a half to one mile length of bank, and are collected in one main channel that formerly served as an access road. Flow then proceeds northward in this channel until reaching the Army's 33-mile Loop Road, where it makes a sharp turn to the east and actually flows in the recessed Loop Road for approximately one mile before leaving the roadway and heading north toward the Alaska Highway. Upon crossing the Alaska Highway and continuing northward, water spreads out in flatter areas and inundates as many as 8-10,000 acres.

Of this at least 4,000 acres are farmland easily eroded by flooding. Flood waters also create a substantial delay for farmers intending to begin spring field work. During years of maximum spring runoff, flooding may be observed along the entire length of the overflow path, from Jarvis Creek to the Tanana River.

Flooding has impaired the state's required agricultural development of several farms. At least 13 farms have not completed required developments at this time, and four others have been sold or are up for sale now due in part to owner frustration at flooding. At the peak of the flooding, fields on at least nine farms are isolated until flood waters recede and the ground has dried sufficiently to allow use of farm machinery. Three houses have had water to their door steps, and at least 15 others have had access restricted during high water periods.

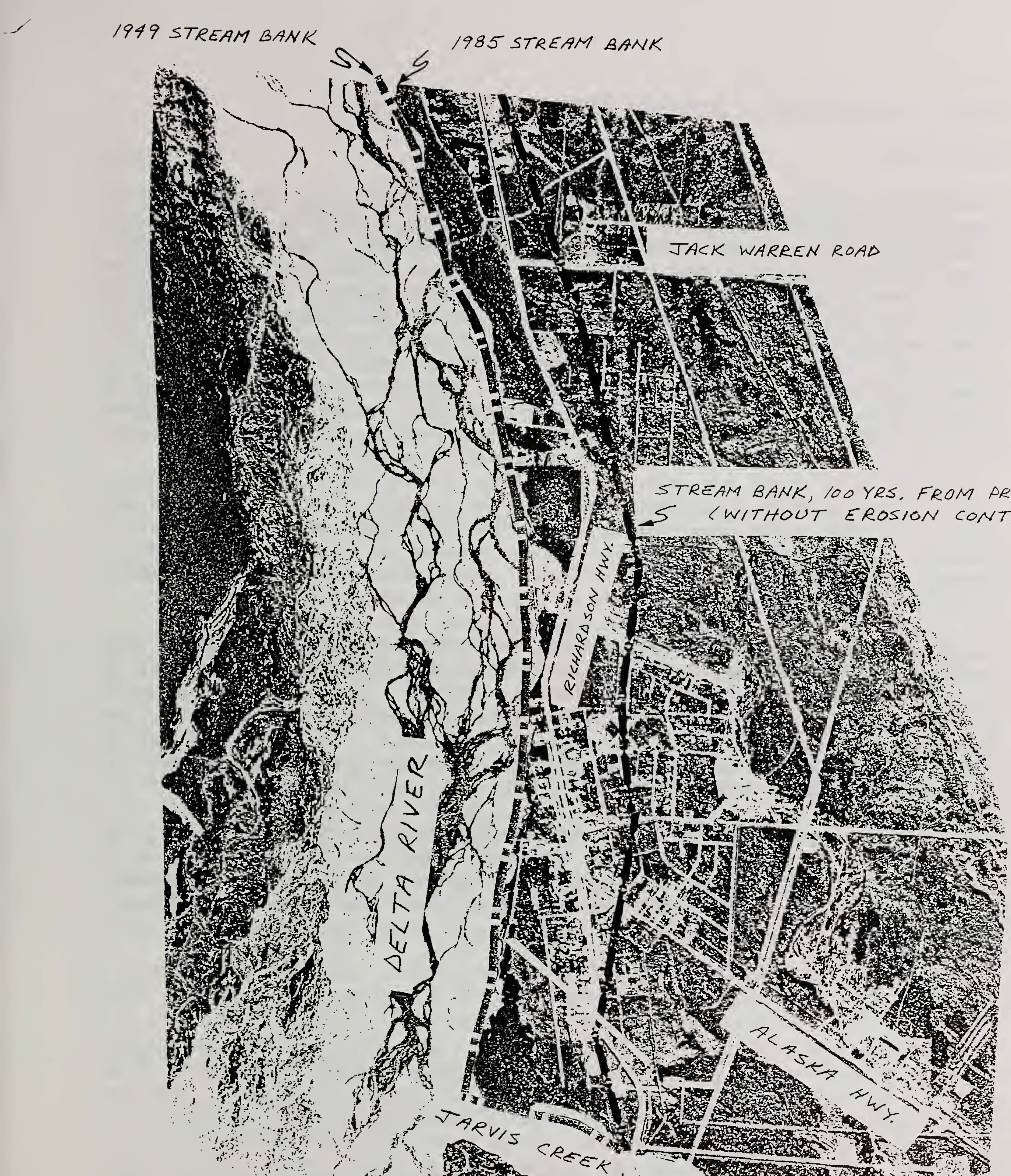
Flooding also impacts the Alaska Highway and nine other roads: H-H-H, Nistler, Jack Warren, Miltan, Berm, Philips, Schenk, Tanana Loop Extension and 33-mile Loop Road (military). The local sanitary landfill is also affected by flooding. Two years ago, the landfill operator built peripheral dikes to provide more protection from flood waters. Flooding of the landfill could affect surface and groundwater quality.

An alternate historic overflow channel runs directly through Delta Junction. This channel has not flooded since 1967 when the U.S. Army built an earthen barrier where the channel leaves Jarvis Creek. This barrier must be maintained as flooding in this channel could result in severe economic losses. Eight office buildings and large shops, one trailer court containing 31 mobile homes, six large apartment buildings, fourteen personal residences, the Delta Junction public school, and the only local public airstrip are all located within the alternate overflow channel.



AREA INUNDATED BY 100 YEAR FLOOD
DELTA RIVER & JARVIS CREEK

FIGURE 3



AERIAL PHOTOGRAPH SHOWING DELTA RIVER BANK EROSION

FIGURE 4

Past Flood and Erosion Control Efforts

Delta River

The City of Delta Junction and property owners along the eastern bank of the Delta River have tried a variety of measures to reduce local erosion. Some individuals have undertaken simple dozerwork, but these efforts generally wash out in a year or two. As early as 1970 several groins were established by one individual and have remained in place. However, lack of maintenance has caused early signs of failure of the structures. In 1980, four groins were installed using surplus concrete pipeline weights and earth fill. The pipe weights were tied together with cables and installed at a slight angle downstream to the bank. These structures have worked to some extent, however, no protection was provided around the end of these groins toward the center of the river. As a result, flow around the ends of groins is causing undermining of the pipeline weights.

Local residents have also installed concrete pilings. These were partially buried in the river bed, in a line from the bank toward the river's center. Three strands of cable were stretched between them to make a permeable flow-through groin. These structures have been somewhat successful, but they are also showing signs of deterioration.

About one mile north of Delta Junction, an earth fill and rock riprap dike approximately 2,500 feet long and parallel to the river was constructed by the Alaska Department of Transportation (ADOT). This dike is currently performing well. Early seral plants, including willows and grasses, are becoming well established on the face of the dike. In April and May of 1985, ADOT added approximately 1,500 feet of dike to further protect the highway.

Within their immediate vicinity, efforts mentioned above have helped slow the landward cutting of the river channel. ADOT's riprap dike may be a project of a magnitude required for lasting protection. Piecemeal individual efforts to halt bank erosion are generally inefficient, expensive for individual property owners, and often in violation of State and Federal laws.

Jarvis Creek

As mentioned previously, the U.S. Army at Fort Greely built an earthen barrier in 1967 where a historic overflow channel leaves the Jarvis Creek channel (approximately six miles upstream of the Delta River). Besides this, the only other flood control effort undertaken on Jarvis Creek is a program of cutting and sanding the aufeis formation each spring. In 1985 and 1986, overflow flooding was reduced by a local group effort which carried out the excavating of a channel in the aufeis formation (with dozer blade or ripper tooth) and spreading of sand (an ice-melting medium) by airplane in and adjacent to the channel. This channel has allowed normal passage of some of the flow which would otherwise overflow. While the cutting and sanding effort has helped to alleviate the overflow flooding problem, it has not approached being a solution to the problem.

FUTURE FLOOD AND EROSION POTENTIAL

General

The City of Delta Junction is not a participant in the National Flood Insurance Program, administered by the Federal Emergency Management Agency (FEMA) through the State of Alaska Department of Regional and Community Affairs. This government program guarantees that federally subsidized flood insurance coverage is available to owners and occupiers of all buildings and mobile homes who subscribe to several set guidelines. In addition, the extent of flooding information provided by FEMA may be used by developers when making land selection and disposal decisions, and when deciding exactly where to build. Delta Junction has not adopted land use management regulations at this time. A planning commission does exist and is considering establishing land use regulations.

State and federal agencies are obligated to regulate their activities to meet certain FEMA requirements. These requirements for structures built within approximate flood and erosion hazard boundaries, stress that:

A. All new construction must

1. Be anchored to prevent movement or collapse during flooding;
2. Use flood-resistant materials and equipment;
3. Be designed and constructed to minimize flood damage.

B. New commercial developments and subdivisions must

1. Be designed and constructed to minimize flood damage;
2. Locate and construct new utilities in ways that minimize or eliminate flood damage;
3. Use flood-resistant materials and equipment;
4. Safeguard new water or sewer systems to avoid infiltration or impairment by floods;
5. Be located away from areas with known high flood and erosion potentials.

In addition to the above requirements, cities participating in the National Flood Insurance Program at the entry (Emergency Program) level, which only have flood boundary maps (no flood elevations are shown) must:

A. Require building or land use permits;

B. Review permit applications to determine if the site is reasonably safe from flooding;

C. Regulate special flood hazard areas;

D. Regulate mobile home siting, tie-downs, and anchoring.

Assuming that flood plain information presented in this report is used as a planning tool and as a means for adopting and enforcing ordinances for flood plain management, future residential, commercial, and industrial development within the flood plain will provide that flood and erosion damages be decreased from present levels. If a sound program of flood plain management is not implemented, damage potential will increase accordingly with new development.

Delta River

Flooding is not a threat in the Delta River study area because Delta River banks are high enough to contain 500-year peak flows. In addition, ice jam flooding is unlikely because river flows remain low until after river ice has melted in mid-to-late spring and early summer.

As discussed in "Flood and Erosion History," Delta River bank erosion has been severe. If no action is taken to prevent erosion, several businesses face collapse into the river. In addition, portions of the Richardson Highway could be threatened. Based upon current levels of development and rates of erosion along the Delta River, estimated annual property losses could be as much as $340,000 if bank erosion is left unchecked. This is based upon current estimates of 20 horizontal feet eroding, yielding a total of five acres of developable land lost every year.

Jarvis Creek

Flooding due to aufeis blockage in Jarvis Creek will cause delays, damage and inconvenience as described in this report, until a remedy to flooding is acted upon. It is estimated that the personal residences, apartment buildings, scattered cabins, highways, roads, culverts, and farmland affected by flooding incur annual damage costs of approximately $30,000. Should a 100-year storm event occur at a time when ground is frozen or partially thawed, estimated damages could exceed $3,000,000. The land area which would be inundated by such an event would be in excess of 30,000 acres.

FLOOD PLAIN MANAGEMENT AND EROSION CONTROL

General

This section discusses the general provisions of a flood plain management program and accompanying erosion control measures. The intent is to furnish an information base should the City choose to establish a flood plain management program. The following also addresses structural alternatives for existing flooding and erosion control problems.

A. Floodway Protection

The floodway is defined as the channel plus the adjacent flood plain area, which must remain free from structural encroachment. The suspected floodways for the Delta River and Jarvis Creek are now protected by present land use. The Delta River floodway consists of the river bed itself. As mentioned previously, a 500-year flood event will not overtop the river banks. However, if the east stream bank is left unprotected the floodway will move toward the city's buildings and roads. Jarvis Creek's floodway is federally owned land within Fort Greely, and development will not occur.

B. Flood Plain Management and Erosion Control Programs

When adopted, regulatory measures will reduce the threat of property damage or loss of life from floods by discouraging development within flood plains. Without certain structural measures, damage to existing property will continue and road and bridge-related damages are likely to increase. As a means of minimizing flood and erosion damage, the following general guidelines should be considered in any flood plain management program:

1. For Existing Properties

a. Incorporate permanent structural measures into existing structures, such as raising the elevation of structures themselves, waterproofing basement and foundation walls, anchoring and reinforcing floors and walls, and using water-resistant materials for construction or refurbishment.

b. Design contingency measures such as the installation of removable bulkheads and installation of a flood warning system to provide advance notice of impending flood danger.

c. Develop emergency plans in advance and ensure that emergency measures will be carried out during flooding. Measures may include sandbagging, pumping, removal of building contents to flood-free areas, and sanding of aufeis areas.

d. Undertake reclamation of flood plains and areas subject to extreme erosion by evacuating developed areas, acquiring these lands by purchase or land trades, removing structures, and relocating evacuees.

e. Ensure that buildings and mobile homes within or adjacent to delineated flood hazard areas carry flood insurance for the dwelling and its contents. Although this will not prevent or reduce existing damage potential, it will have the effect of reducing incurred damage costs by spreading costs among all participants of the flood insurance program.

f. Plan and implement a system of structures which will reduce flooding and/or severe annual erosion losses. This alternative should only be considered when substantial developments are already in place, when annual flood and erosion losses are significant, and when public sentiment and support demands the action. The previous five guidelines should be considered and implemented, if feasible, prior to implementation of this measure.

2. For Future Road and Bridge Construction

   a. When analyzing future alternative transportation routes, the cost of potential flood and erosion damage should be investigated and included for use in the decision making process.

   b. Construction designs should reflect sound engineering judgement with regard to flood and erosion hazard potential. Engineering should include analysis of soils, geology, hydrology, and hydraulics, as well as adequacy of construction materials.

3. Other Future Property Developments

   a. City and State land sales should not include land within the boundary of either the 100-year flood event, or the critical stream bank erosion zone.

   b. Regulations should be enacted which forbid the construction of new dwellings or other structures within the boundary of either the 100-year flood event or the critical stream bank erosion zone.

Alternatives Considered

Alternatives for controlling flooding and stream bank erosion have been considered by the City of Delta Junction and the general public. Some discussion was carried out prior to formal initiation of this flood plain management study. A public meeting was held November 17, 1983, which 40 citizens of Delta Junction attended.

Priorities for future planning and possible capital improvement projects for the City were the main topics of discussion. Erosion, specifically along the Delta River, and flood prevention were found to be the top concerns of Delta's citizens. With this in mind, the City applied for and received from the State capital improvement project funding in the amount of $950,000 to plan and construct erosion control structures along the Delta River. Funding for Jarvis Creek work is presently not available.

The alternatives for management and control of flooding and stream bank erosion are discussed below. Assessments of each structural alternative are included in the "Comparison of Alternatives" section. Alternatives are:

A. No Action - Do nothing and continue to incur losses as stated in this report.

B. Nonstructural

   1. <u>Insurance</u> - An insurance program could be implemented for property owners affected by Delta River erosion and Jarvis Creek overflow flooding. A subsidy might be obtained through federal, state, or local sources. The City and/or State should take whatever action is necessary to make flood insurance available for property subject to flood damage (including areas adjacent to the delineated flood hazard areas). Owners should be encouraged to purchase this insurance for their land, buildings, mobile homes and contents within.

   2. <u>Zoning</u> - The enactment of ordinances which regulate the location of new development to prevent further building in high hazard areas. As a minimum, adopt and enforce flood plain regulations as outlined by the National Flood Insurance Program. Regulations should address such things as minimum floor elevations, floodway boundaries, location of greenbelt areas, adequate drainage facilities, building and housing codes, and sanitary codes, with specific flood hazard provisions for all new construction. Land development ordinances should include provisions for onsite runoff and sediment storage. A continuous maintenance program should be adopted for any type of new permanent structure.

   3. <u>Other</u> - Two possibilities include (1) relocation of the city, or (2) purchase of property as erosion occurs. Either of these would be very expensive, and presently the City has no means for generating funds to implement such a program. Flood damage in general may be alleviated by flood plain acquisition, flood proofing, and flood forecasting and warning systems. Federal cost sharing for these measures may be available under Section 73(b) of Public Law 93-251. The National Weather Service of the National Oceanic and Atmospheric Administration issues warnings for potential flood producing storms. Frequently flood warnings are preceded by a "severe weather watch" or "flood watch."

C. Structural

1. Delta River Stream Bank Erosion - The following describes several structural alternatives for controlling bank erosion. Design drawings and location maps for the alternatives are shown in figures as stated. Table 1 in the "Comparison of Alternatives" section of this report compares costs for the different alternatives.

   a. Continuous Rock Protection (Figure 5) - The river bank would be flattened to a stable slope, fill material added as needed, and riprap or gabion basket armor placed to prevent further erosion. This is the only alternative being considered for stabilization of the initial 4,800 feet of the project, known as the Jarvis segment. For the remaining length of the project, the Delta Segment, this method will be considered along with other alternatives.

   b. Continuous Dike (Figure 6) - An earthen dike armored with riprap or gabions, or a dike constructed of stacked gabions (see Figure 8 for design), would be built approximately parallel to and abutting the river bank. Earth fill and rock for gabions would be of excavated river bed material.

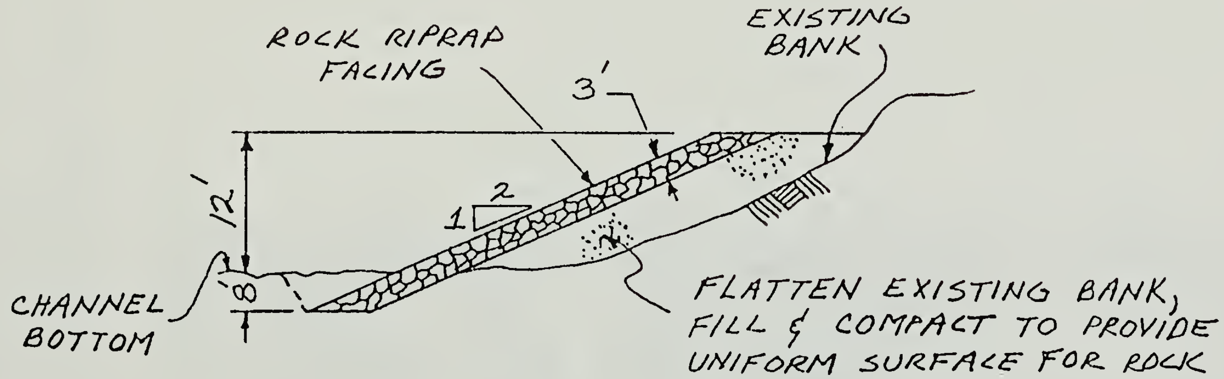
   c. Groins (Figure 7) - A series of "finger dikes" would be built out into the river bed at either 45° or 90° angles to the river bank. They would be earthen and protected on the upstream side and ends by riprap or gabions, or constructed of stacked gabions. The length of each groin would be approximately 400 feet. A groin functions by creating an eddy which causes sediment to settle out on the downstream side of the groin, thereby building and protecting the existing bank. The spacing between groins is such that the deposition area from each groin is large enough to create a continuous area of "new" stream bank.

   d. Pile and Cable (Figure 9) - Steel, wooden or concrete pilings would be driven or placed into the river bed in rows and would extend from the river bank out into the river at an angle to the bank. Pilings would be connected with heavy steel cables which would catch and entangle floating brush and logs, creating a semi-pervious barrier to flowing water. This would both slow the flow and create eddies which, like groins, would allow sediment to drop and form a "new" stream bank. Technical data, material quantities and costs for this alternative are not included in this report.

Note on Delta River erosion control efforts - At the time of completion of this study, the City of Delta Junction was utilizing the state capital improvement funding granted in 1983 by constructing groins to prevent further immediate bank erosion. Project design was prepared by

a private consultant based on preliminary plans developed for this study. The work is divided into four phases. Phases I, II and III involve refurbishing existing groins and constructing new groins. Contractors for phases I, II and III were selected by a competitive bidding process and work completed during the summer of 1987. Phase IV also involves construction of groins, however, funding for this project is lacking at this time.

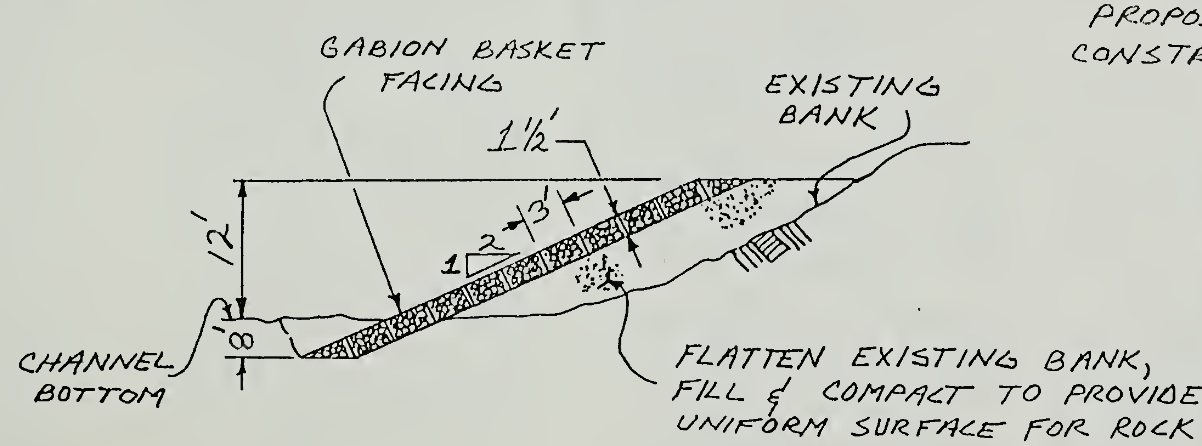
NOTE: DRAWINGS NOT TO SCALE



FLATTENED BANK W/ RIPRAP

SECTION VIEW

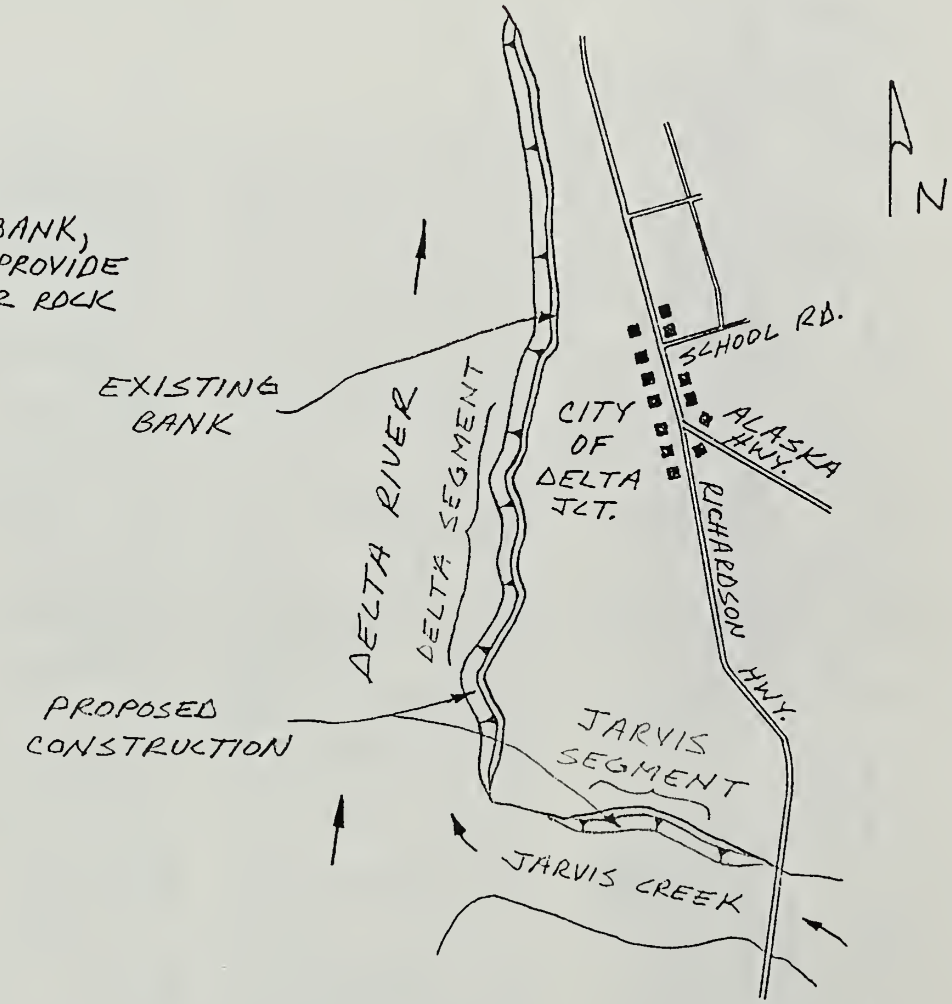
FIGURE 5A



FLATTENED BANK W/ GABIONS

SECTION VIEW

FIGURE 5B



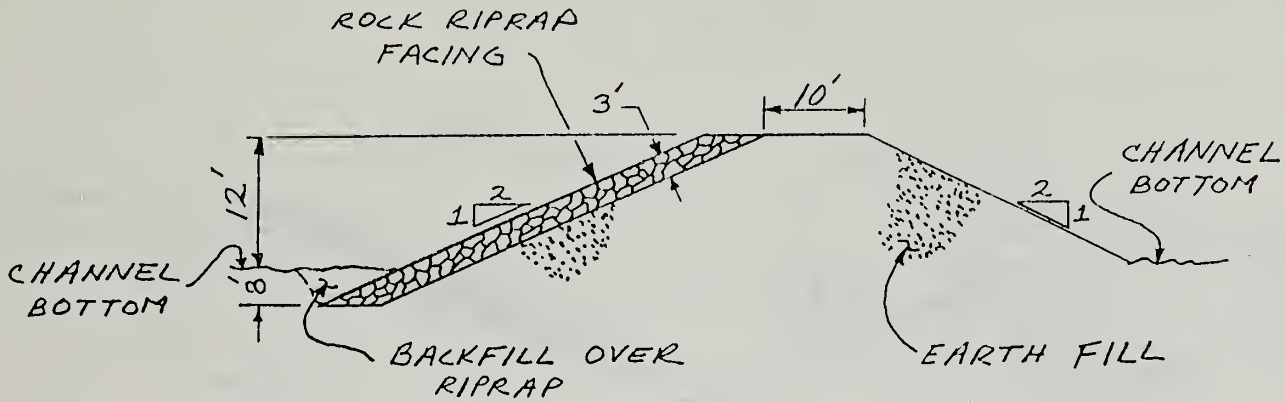
FLATTENED BANK ALTERNATIVE

PLAN VIEW

FIGURE 5C

FIGURE 5

NOTE: DRAWINGS NOT TO SCALE

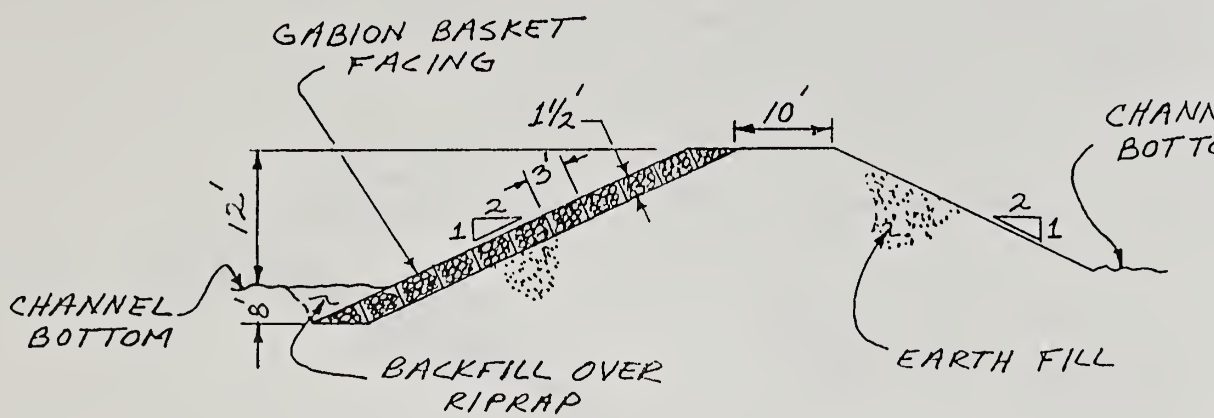


SEE FIGURE 8 FOR ALTERNATE DIKE DESIGN

DIKE W/ RIPRAP

SECTION VIEW

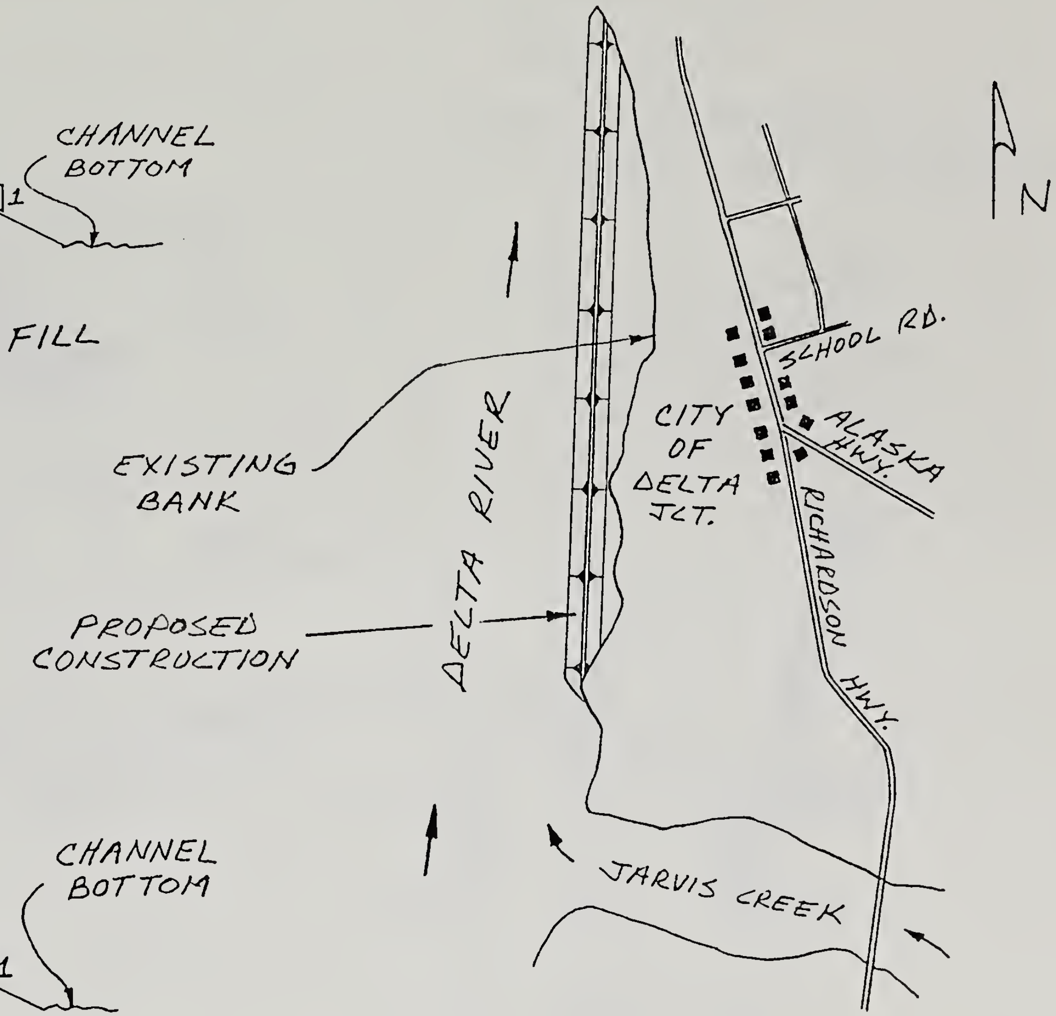
FIGURE 6A



DIKE W/ GABIONS

SECTION VIEW

FIGURE 6B



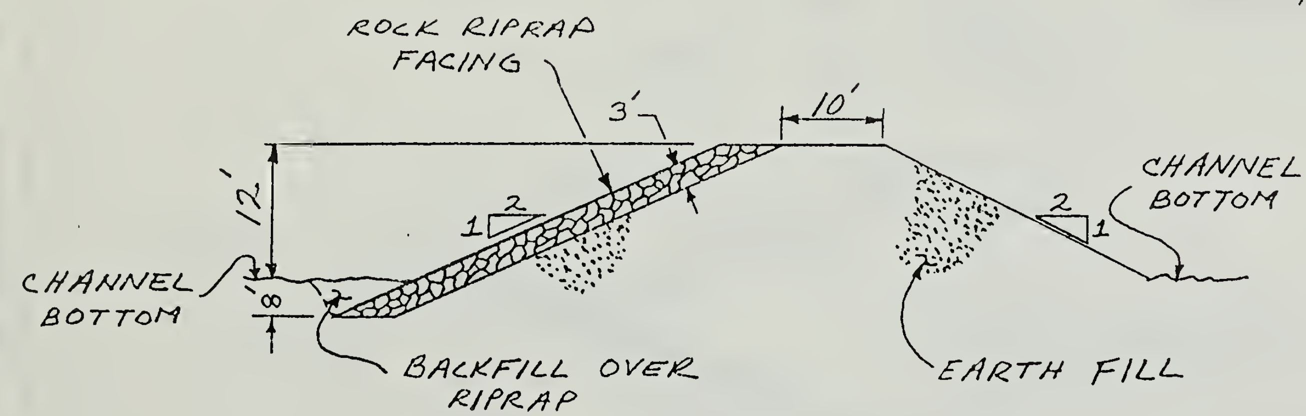
DIKE ALTERNATIVE

PLAN VIEW

FIGURE 6C

FIGURE 6

NOTE: DRAWINGS NOT TO SCALE

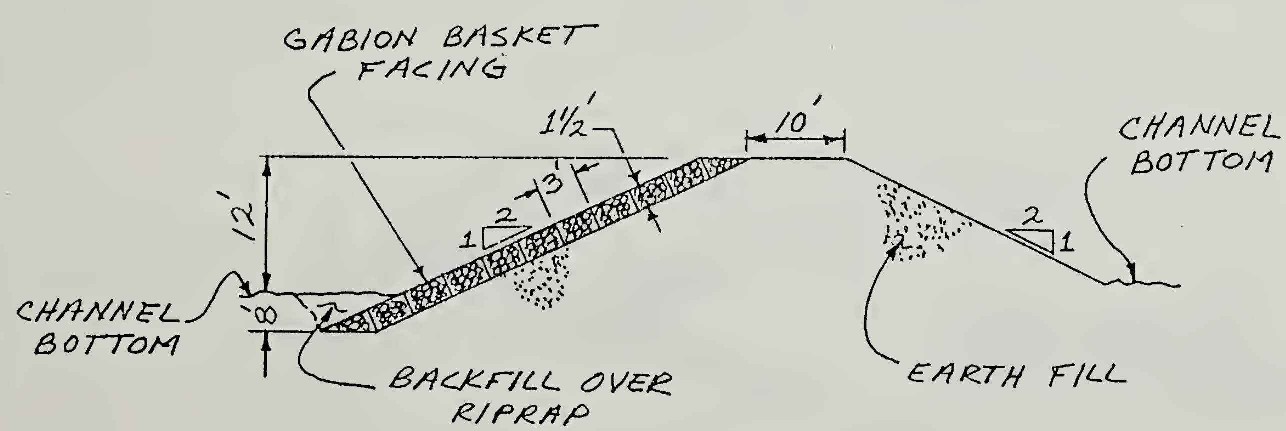


GROIN W/ RIPRAP

SECTION VIEW

FIGURE 7A

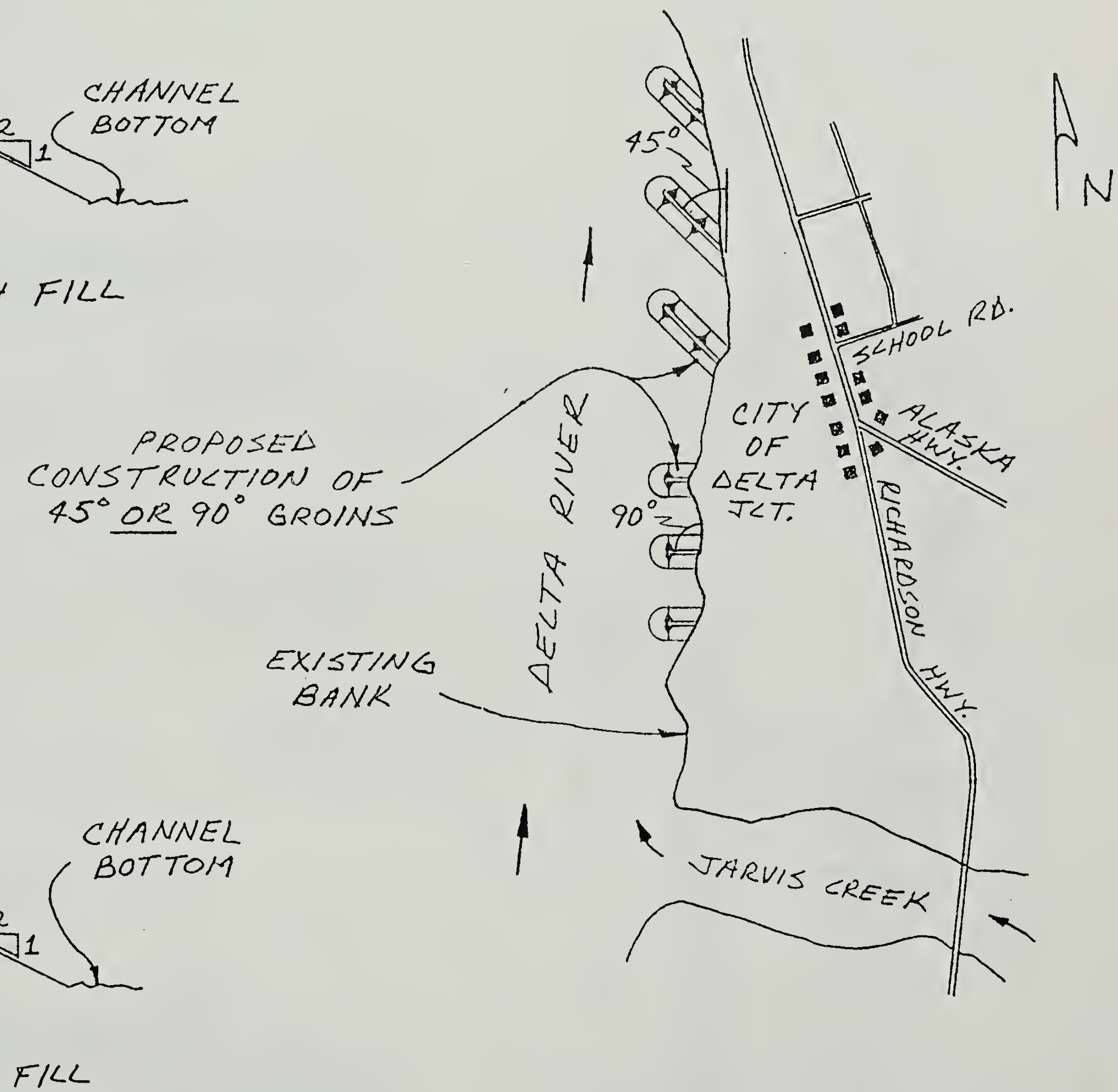
SEE FIGURE 8 FOR ALTERNATE DIKE DESIGN



GROIN W/ GABIONS

SECTION VIEW

FIGURE 7B

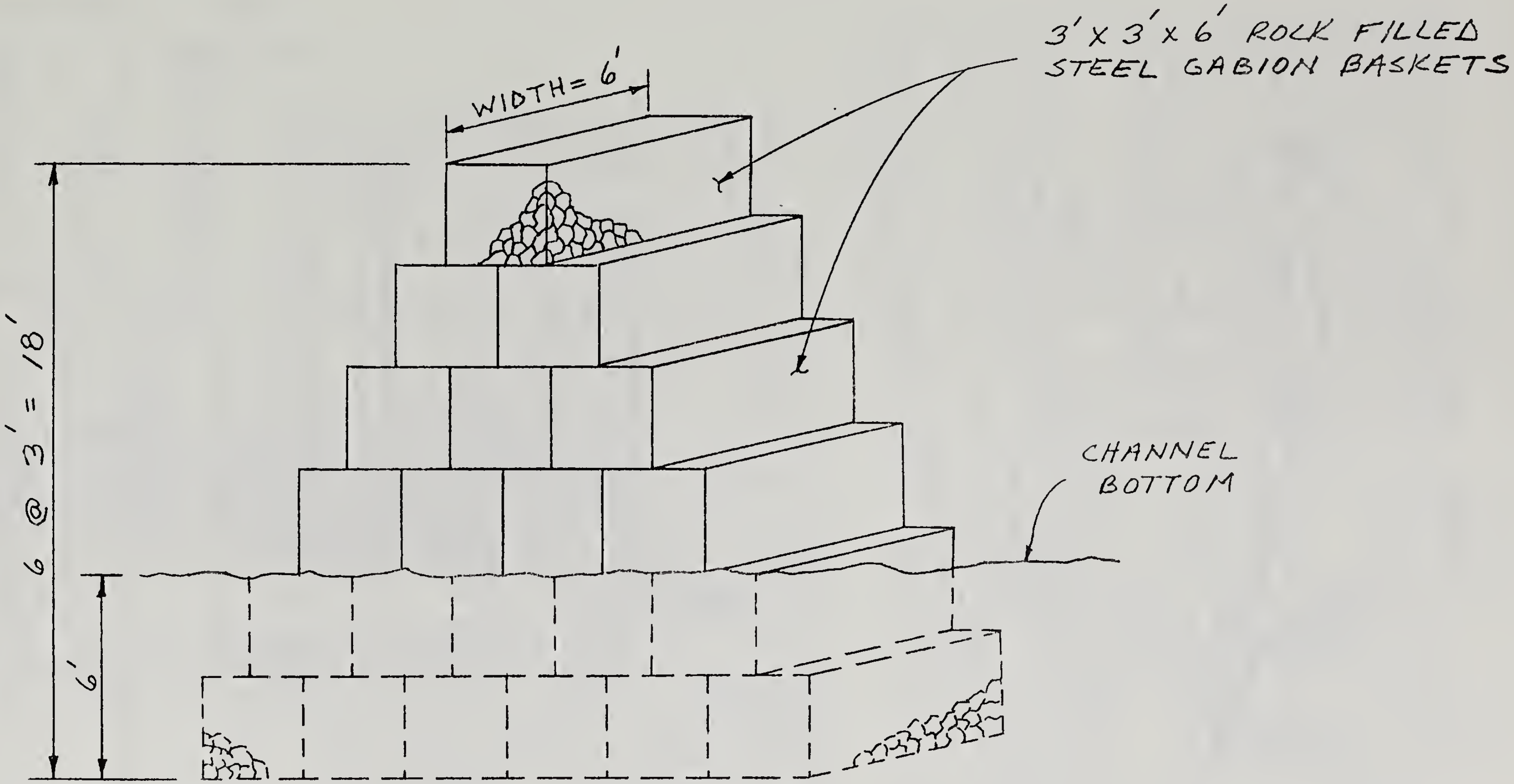


GROIN ALTERNATIVE

PLAN VIEW

FIGURE 7C

FIGURE 7



NOTE:
STACKED GABIONS TO BE CONSIDERED AS ALTERNATIVES TO DIKES IN FIGS. 6A & 6B AND TO GROINS IN FIGS. 7A & 7B.

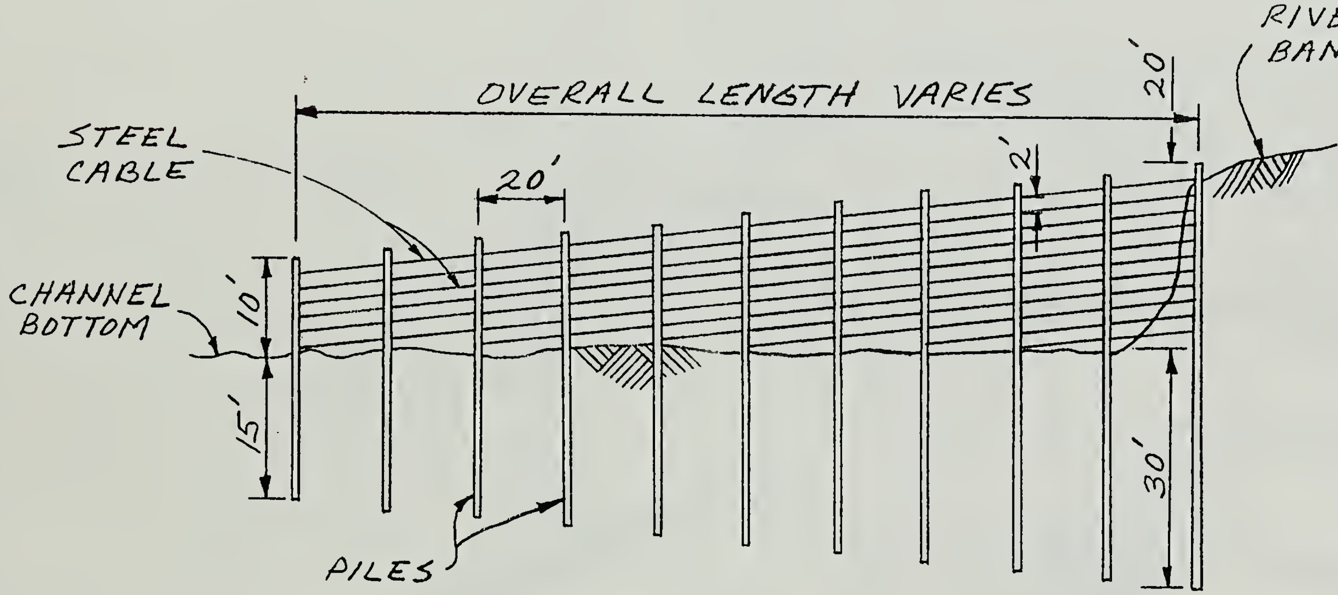
SCALE: 1" = 6'

STACKED GABION DESIGN

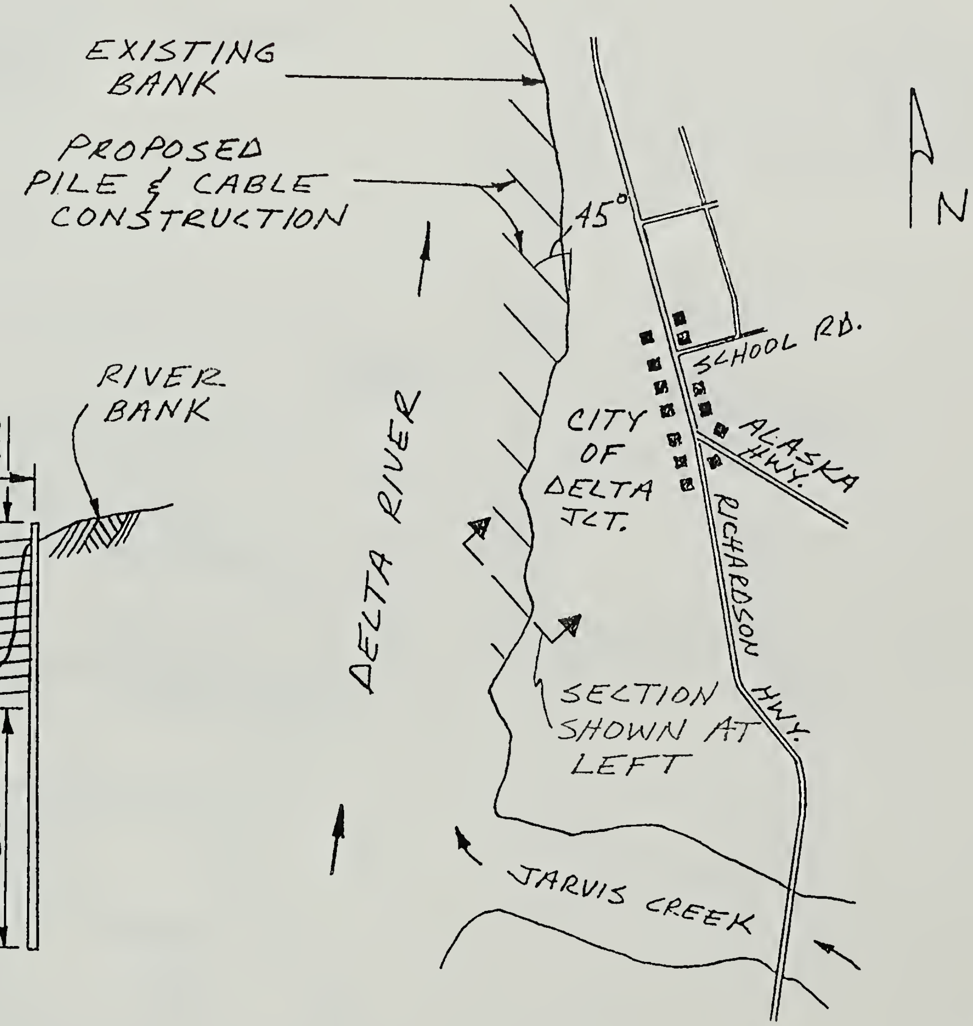
FIGURE 8

NOTE: DRAWINGS NOT TO SCALE

SUGGESTED PILE MATERIALS INCLUDE STEEL PIPE OR RAIL, TREES OR WOODEN UTILITY POLES, & REINFORCED CONCRETE



PILE & CABLE
SECTION VIEW
FIGURE 9A



PILE & CABLE ALTERNATIVE
PLAN VIEW
FIGURE 9B

FIGURE 9

2. Jarvis Creek Overflow Flooding - The following presents structural alternatives for controlling flooding. Five separate alignments are proposed with structures for each consisting of overland earth fill dike and/or channel dike, or excavated overflow channel. Use of rock riprap for dike armoring is addressed, while use of rock filled gabion baskets has been excluded to simplify the presentation of alternatives. Gabions may be used instead of riprap for dike armoring in final design plans, based on cost comparison and availability of rock.

Location maps for alternatives are shown in figures 10 and 11. Design drawings are shown in Figures 12, 13 and 14. Table 2 in the "Comparison of Alternatives" section of this report compares cost totals for the different alternatives.

Alternative I - 4,300 foot overland dike connecting to 21,000 foot channel dike:

An overland dike would extend northwest from the base of Jack Warren moraine to the east bank of the Jarvis Creek channel, where a channel dike would continue to a point downstream past a historic overflow channel. The overland dike would be built of earth fill excavated from the Jarvis Creek channel and would have its south side armored with riprap or would be left unarmored but for seeding and natural vegetation left undisturbed during construction. The channel dike would abutt the creek bank and would also be built of material excavated from the Jarvis Creek channel. Its sloping face would either be armored with riprap or left unprotected. The overland dike would divert floodwater back into the Jarvis Creek channel while the channel dike would contain water within Jarvis Creek downstream to a point where flows may travel untrained in Jarvis Creek out to the Delta River.

Alternative II - 12,200 foot overland dike connecting to 7,200 foot channel dike:

Dikes would be constructed and would function as in Alternative I.

Alternative III - 18,600 foot overland dike:

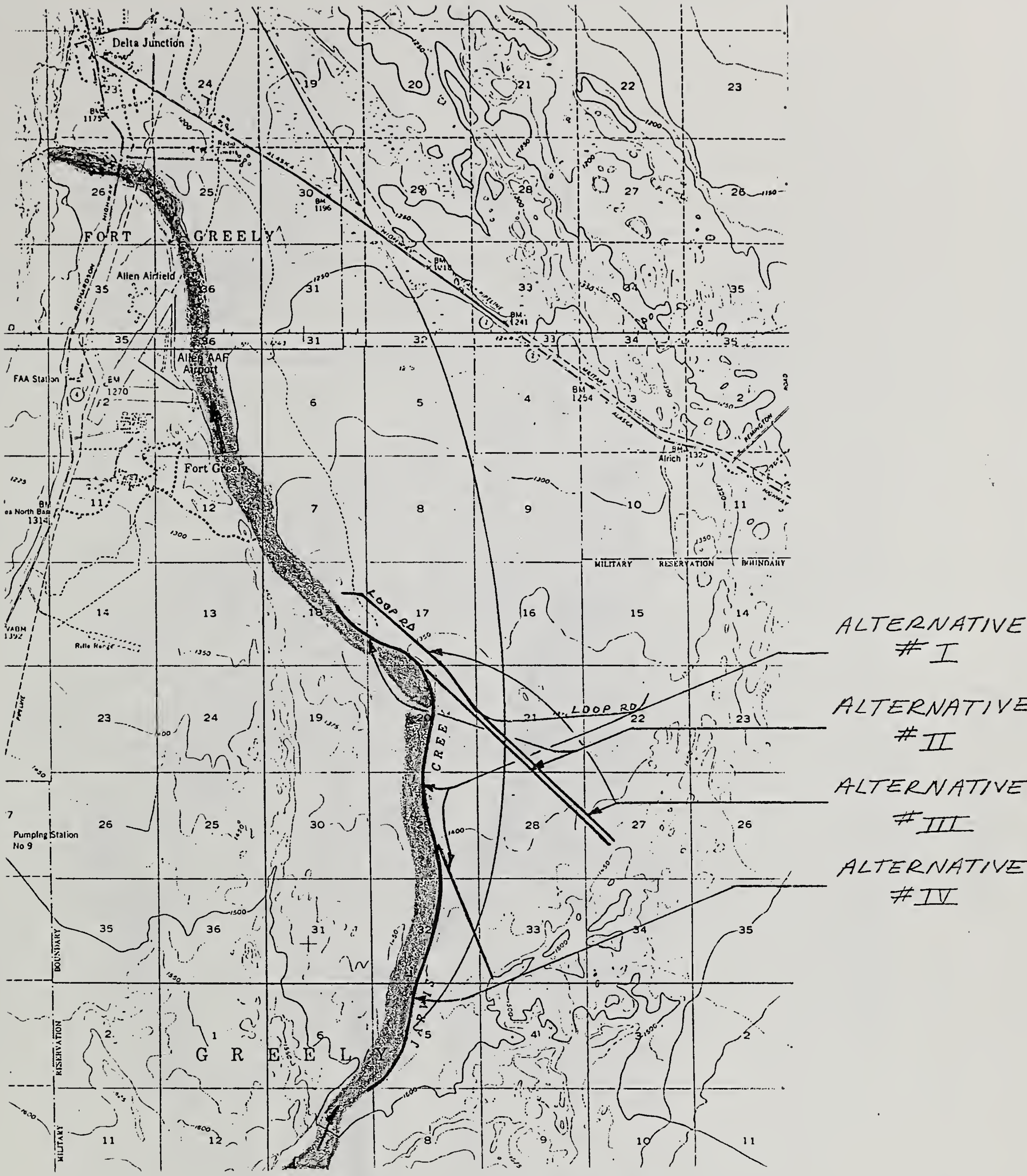
Overland dike would be constructed as in Alternatives I and II. However, the downstream end of this alignment coincides with the existing 33 mile Loop Road and the dike would be built either abutting the roadbed or incorporated as part of the road itself.

Alternative IV - 31,000 foot channel dike:

A dike would be built along the east bank of the Jarvis Creek channel and would contain flow within the channel, as in the downstream portion of Alternatives I and II. The dike would essentially run the entire length of channel where overflow flooding caused by aufeis blockage has the potential to occur.

Alternative V - 20 mile (106,000 foot) overflow channel from Jarvis Creek north to the Tanana River:

A channel would be constructed along the main path of overflow flooding; from the east bank of Jarvis Creek northward across the Alaska Highway, to within one to two miles east of the Delta Junction city center, through agricultural lands northeast of the city to its discharge point at the Tanana River. The channel would be seeded to establish permanent vegetative cover for erosion control. This alternative would have the dual function of providing a controlled flowpath for floodwater while acting as a collector for surface drainage from adjacent residences and farms.



LENGTH IN FEET

	#I	#II	#III	#IV
OVERLAND DIKE	4,300	12,200	18,600	
CHANNEL DIKE	21,000	7,200		31,000

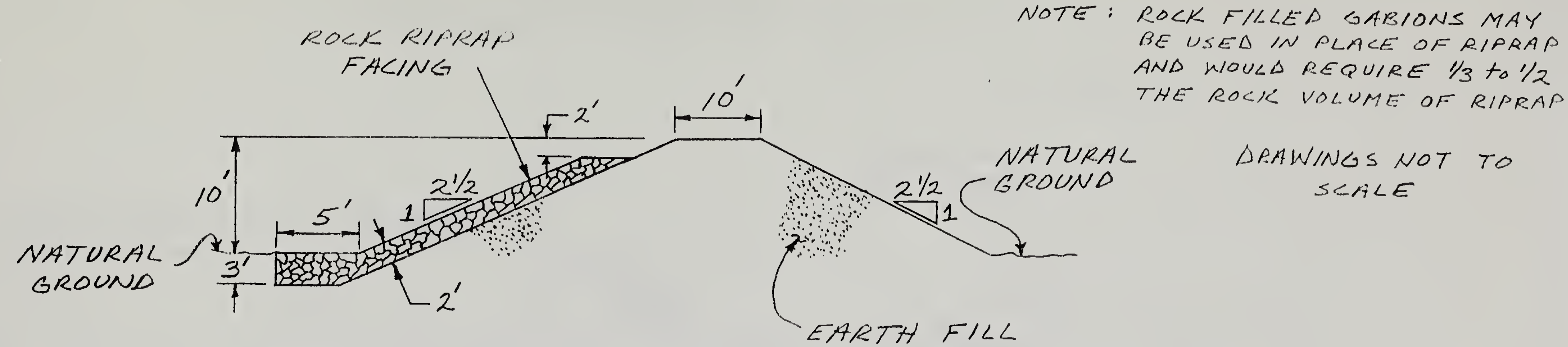
PROPOSED ALIGNMENTS
STRUCTURAL ALTERNATIVES #I, #II, #III & #IV

FIGURE 10

#V - OVERFLOW CHANNEL
LENGTH = 106,000 FT. (20 MI.)

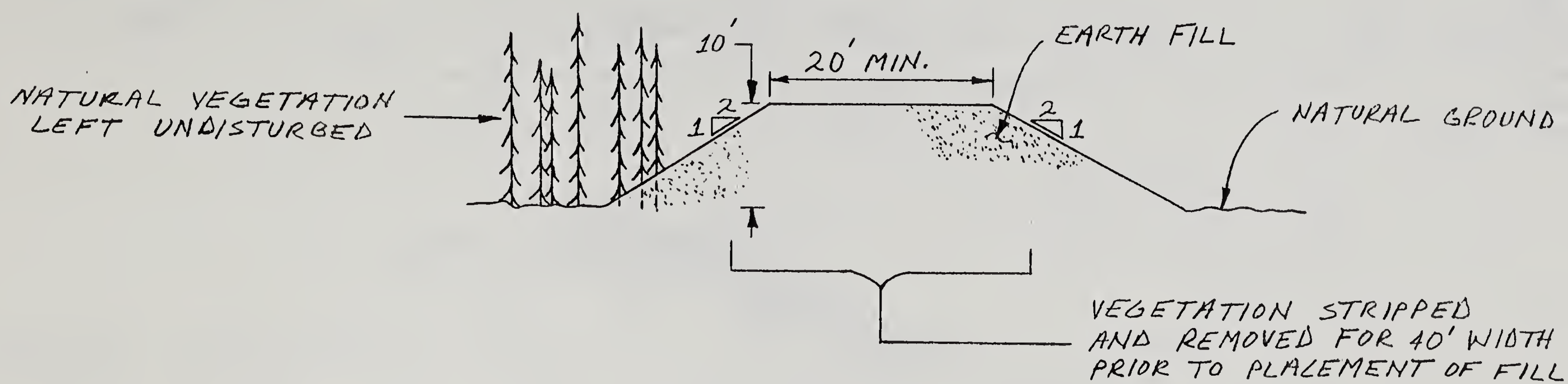
PROPOSED ALIGNMENT
STRUCTURAL ALTERNATIVE #V

FIGURE 11



OVERLAND DIKE W/ RIPRAP

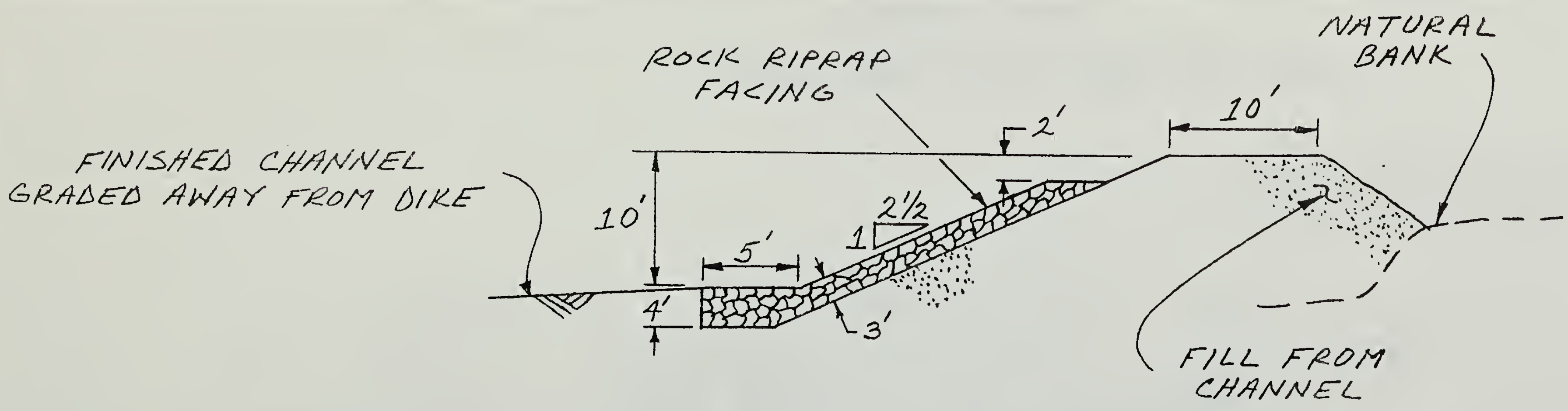
FIGURE 12A



OVERLAND DIKE W/O RIPRAP

FIGURE 12B

FIGURE 12

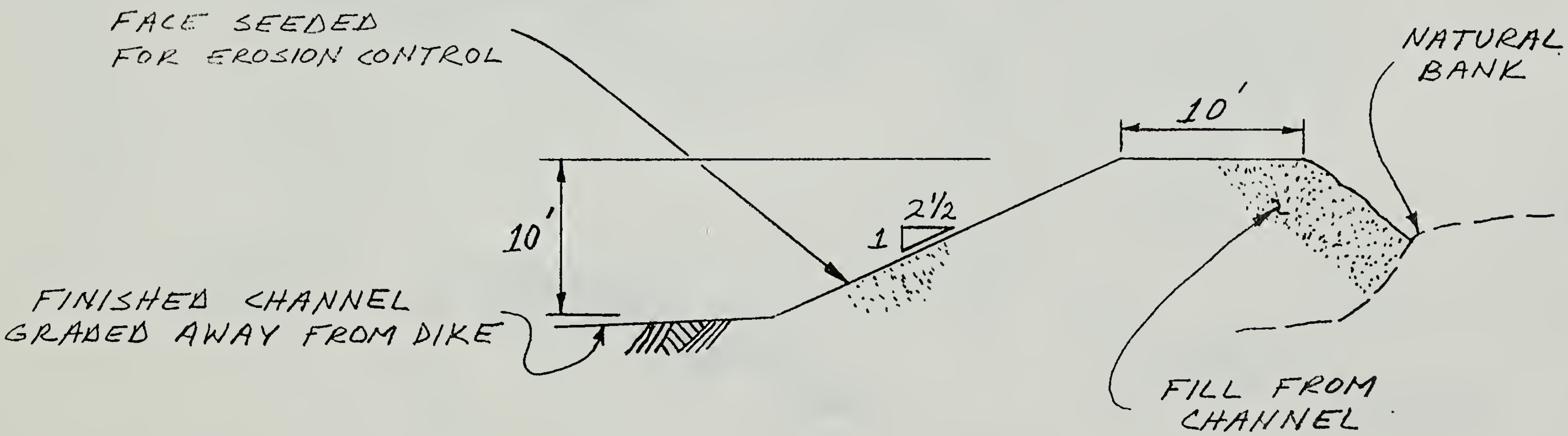


CHANNEL DIKE W/ RIPRAP

FIGURE 13A

NOTE: ROCK FILLED GABIONS MAY BE USED IN PLACE OF RIPRAP AND WOULD REQUIRE 1/3 TO 1/2 THE ROCK VOLUME OF RIPRAP

DRAWINGS NOT TO SCALE

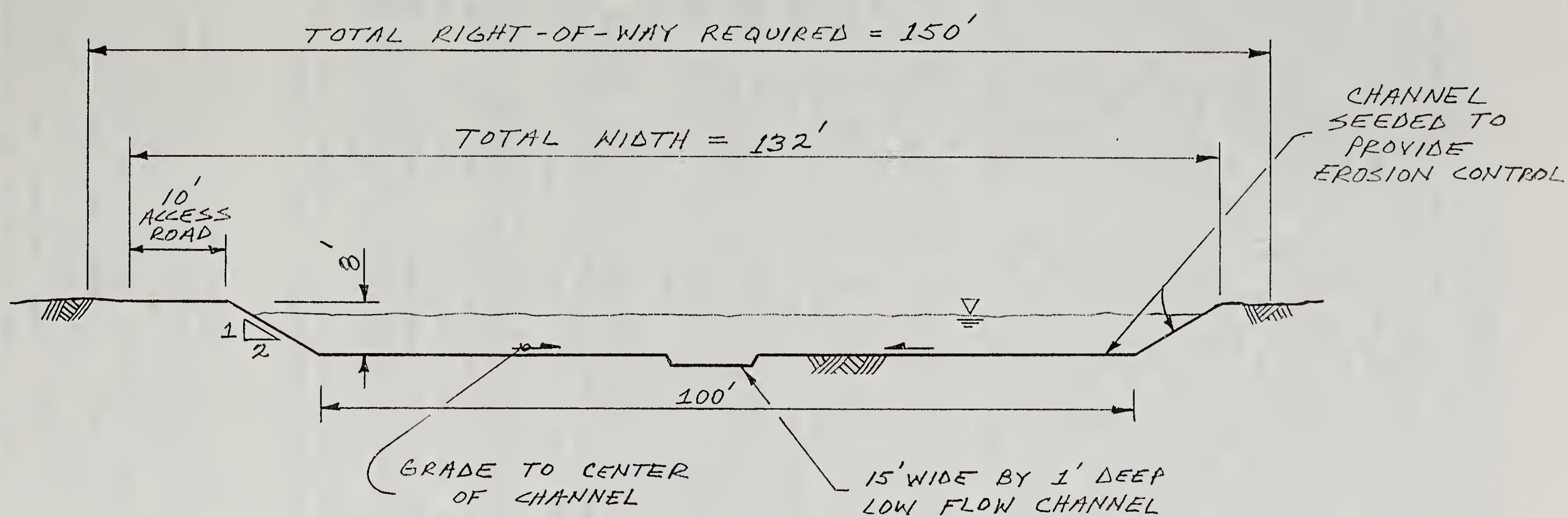


CHANNEL DIKE W/O RIPRAP

FIGURE 13 B

FIGURE 13

NOTE: DRAWING NOT TO SCALE



OVERFLOW CHANNEL DESIGN

FIGURE 14

Additional Jarvis Creek Alternatives

Supplemental to the five structural alternatives presented in the preceding would be to allow overflow to reach the Alaska Highway, as presently occurs, and channelize flows past this point in sections through areas of greatest human/economic value only. This would require channel segments similar in design to the overflow channel of Alternative V. One location where an improved channel section would be beneficial would be from the Alaska Highway north for one to two miles. From this point flow could be left untrained to travel the overflow route northward through undeveloped land to Jack Warren Road. Flow could then be fully channelized and routed northward (as in Alternative V), or westward along Jack Warren Road to the Delta River (the latter is prohibitive as it would entail expensive, potentially difficult crossings of the Alaska Pipeline and Richardson Highway). In general, improving the present overflow route in sections is considered to be a "piecemeal" solution to the flooding problem, and while it may be considered an alternative, is not addressed further in this report.

A means of preventing flooding already in use in recent years, is a program of cutting a channel in the ice with a bulldozer and sanding that portion of the Jarvis Creek channel. This opens up a channel for flow and encourages melting of the aufeis formation, thus reducing flood potential. Though cutting and sanding has been effective, those familiar with operations estimate that it would take 10 to 15 times the work currently done to actually eliminate overflow flooding. It should be noted that this would be a cost incurred each year. Spending for cutting and sanding in 1985 and 1986 totaled approximately $4900 and $9600, respectively.

Further ideas for controlling Jarvis Creek flooding have been considered. However, they are not discussed in detail in this report for reasons given.

a) Use of explosives for clearing a channel in the aufeis formation - Basically would accomplish the same task as the presently used cutting and sanding operation, that is, providing passage for spring runoff while speeding up melting of the aufeis formation. Blasting is not considered as an alternative to cutting and sanding as estimates show it to be a much more expensive procedure. However, blasting applied in conjunction with dozer cutting in areas of greater apparent risk to dozer operators may be a consideration.

b) Melt ice lenses in channel bed to increase channel capacity - Presence of permafrost within the study area indicates a climate which may be conducive to the forming of permanent ice lenses within the earth material making up the Jarvis Creek channel bed. If ice lenses exist, summertime operations of melting all or portions of lenses, thus turning ice to flowing groundwater, would in effect serve the same purpose as mining sediment from the channel bed; channel capacity would be increased, thereby providing a storage area for sediment or possibly creating a situation at the

point of aufeis blockage which is slightly erosional, rather than depositional. Determining location and size of ice lenses, if in fact they are found to exist, and investigating methods for melting lenses, is felt to be beyond the scope of this study.

c) Construct "sediment trap" upstream of area of aufeis blockage - A drop structure, or small overflow dam, four to five feet in height would be built across the entire width of the Jarvis Creek channel (approximately 1500 feet), two to three miles upstream of the point of overflow flooding. The structure would slow Jarvis Creek waters, causing a dropping out of sediment at that point rather than downstream, where the accumulation of sediment flattens the bed slope, encouraging the formation of aufeis. Thus, a large "sacrifice area" would be created upstream which would act as a location for controlled sediment storage. This idea, while possibly of merit, is felt to be beyond the scope of this study for three reasons: 1) lack of data supporting the effectiveness of this technique in a true braided stream situation, 2) lack of data regarding the volume of sediment carried by Jarvis Creek, 3) uncertainty as to the long term effectiveness of this proposal; in other words, will the created sediment storage area fill to capacity in a short period of time (say five years or less), thereby requiring a new investigation for solving the overflow flooding problem.

d) Open creek channel to gold or gravel mining - Mining with drag lines, dredges or by other means could be done in a manner which could ultimately result in containment of flood flows. Material would be excavated from the creek channel, providing extra flow capacity, and unused portions of material piled along the east creek bank to form a dike. While this is an idea which deserves mention, an interested party would need to consider the following: 1) marketability of gravel based on local economy and haul distance, 2) profit margin involved with gold mining operation, 3) whether the Army would permit private enterprise on Fort Greely land.

Environmental impacts, permits required, etc. would need to be addressed should any of the above ideas be considered further.

COMPARISON OF ALTERNATIVES

General

The following provides a cost comparison for structural flood and erosion control measures presented in this report. Environmental considerations are discussed in detail in Appendix B. Final decisions as to the course of action to be taken shall be based on combined economic and environmental effects.

For this study, some costs are based upon the spring 1985 construction of the Alaska Department of Transportation (ADOT) dike on the Delta River immediately north of the Delta River study area. Other costs are based upon estimates for work done on an equipment rental basis, adjusted locally for Delta Junction. Gabion costs were provided by Tera Aqua Inc. Further information on costs used for estimates is given below. Annual operation and maintenance cost is estimated at 0.5% of the original construction cost. It should be noted that although cost estimates are based on certain assumptions and resulting costs are approximate, a direct cost comparison between alternatives is still possible.

Delta River

Table 1 shows material quantity and cost, total construction cost, and yearly operation and maintenance cost estimates for the structural alternatives presented. Assumptions used in deriving material and cost estimates are as follows:

1. Structures will be built to the dimensions shown in Figures 5, 6, 7, 8 and 9.

2. Fill material will be excavated from the river bed or from pits close to the project, and will cost $3.60 per cubic yard, in place.

3. All earth fills will be armored on the river or upstream side with either rock riprap or rock filled gabion baskets, extending vertically down into the river bottom. Ends of groins (finger dikes) will be armored with 15% more rock than shown on design drawings for increased protection.

4. Riprap rock will be excavated and hauled from an ADOT borrow pit approximately 10 miles north of the project, and will cost $45 per cubic yard, in place.

5. Gabions can be substituted for riprap, and will require half the rock volume of riprap.

6. Gabions will be constructed from rock screened from the river bed. 12.5% of the material screened will be sufficiently large enough for use. Cost for screening, transporting rock, and filling baskets is $42 per cubic yard. This includes cost for ground laborers and for steel gabion baskets, delivered to the site (assumed to be $1.10 per pound).

7. Costs for mobilization, surveying, erosion and pollution control, temporary dikes, site dewatering, etc., have been included in the unit cost for fill, rock, and gabions to simplify estimates.

An important long term impact upon cultural and economic resources is that with any construction that takes place, the City will become committed to operation and maintenance of the project, thus incurring continual expenses. Future structural work may be required to assure long term success of the project.

Any of the structural alternatives chosen will have a different effect upon the postconstruction stream bank. The work will, in effect, create the opportunity for shoreline residents to reclaim land that had previously been lost to erosion. A survey was conducted to determine if the affected property owners would like to reclaim the lost land. Ten land owners are affected, and of the nine that were contacted (one could not be reached), all said they would eventually reclaim lost land if it were possible.

TABLE 1

COMPARISON OF STRUCTURAL ALTERNATIVES
DELTA RIVER EROSION CONTROL

STRUCTURE TYPE	TECHNICAL DATA Structure Length (FT)	Total Length (FT)	MATERIAL QUANTITY Earth Fill (CY)	Rock (CY)	Gabions* (LBS)	MATERIAL COST Earth Fill ($)	Rock ($)	Gabions* ($)	TOTAL CONSTRUCTION COST ($)	ANNUAL OPERATION AND MAINTENANCE COST ($)
Flattened Bank										
Jarvis Segment										
rock riprap	4,800	4,800	-------	23,900	-------	--------	1,075,000	-------	1,075,000	5,000
gabion basket	4,800	4,800	-------	12,000	336,000	--------	492,000	370,000	862,000	4,000
Delta Segment										
rock riprap	6,400	6,400	-------	31,800	-------	--------	1,431,000	-------	1,431,000	7,000
gabion basket	6,400	6,400	-------	16,000	448,000	--------	656,000	493,000	1,149,000	6,000
Dike										
Delta Segment										
earth fill rock riprap	6,200	6,200	93,700	30,800	-------	337,000	1,386,000	-------	1,723,000	9,000
earth fill gabion basket	6,200	6,200	93,700	15,500	434,000	337,000	636,000	477,000	1,450,000	7,000
stacked gabion basket	6,200	6,200	-------	43,400	933,100	--------	1,179,000	1,026,000	2,806,000	14,000
Groins										
Delta Segment										
45 degree (620-ft spacing)										
earth fill rock riprap	382	4,200	63,500	23,800	-------	229,000	1,035,000	-------	1,264,000	6,000
earth fill gabion basket	382	4,200	63,500	12,375	346,500	229,000	507,000	381,000	1,117,000	6,000
stacked gabion basket	382	4,200	-------	29,400	632,100	-------	1,205,000	695,000	1,901,000	10,000
90 degree (900-ft spacing)										
earth fill rock riprap	330	2,000	30,200	11,400	-------	109,000	513,000	-------	622,000	3,000
earth fill gabion basket	330	2,000	30,200	5,750	161,000	109,000	236,000	177,000	522,000	3,000
stacked gabion basket	330	2,000	-------	14,000	301,000	-------	574,000	331,000	905,000	5,000
90 degree (600-ft spacing)										
earth fill rock riprap	330	2,000	45,300	17,100	-------	163,000	770,000	-------	933,000	5,000
earth fill gabion basket	330	2,000	45,300	8,625	241,500	163,000	354,000	266,000	782,000	4,000
stacked gabion basket	330	2,000	-------	21,000	451,500	-------	861,000	497,000	1,358,000	7,000
90 degree (300-ft spacing)										
earth fill rock riprap	330	5,800	87,600	33,200	-------	315,000	1,494,000	-------	1,809,000	9,000
earth fill gabion basket	330	5,800	87,600	16,675	466,900	315,000	684,000	514,000	1,513,000	8,000
stacked gabion basket	330	5,800	-------	40,600	872,900	-------	1,665,000	960,000	2,625,000	13,000

* Represents steel basket only

Jarvis Creek

Table 2 shows material quantity and cost, total construction cost, and yearly operation and maintenance cost estimates for the structural alternatives presented. Assumptions used in deriving material and cost estimates are as follows:

1. Structures will be built to the dimensions shown in Figures 10, 11, 12, 13 and 14.

2. Fill material for dikes will be excavated from the creek bed or from pits close to the project, and will cost \$5.00 and \$4.00 per cubic yard, in place, for overland dikes and channel dikes, respectively.

3. Riprap rock will be excavated and hauled from an ADOT borrow pit approximately 20 miles north of the project, and will cost \$50 per cubic yard, in place.

4. Excavation for overflow channel construction will cost \$3.40 per cubic yard. This cost includes crossing of the Alaska Highway, right-of-way purchase and channel seeding.

5. The salvage value of trees cut in land clearing operations is incidental to project cost.

6. Costs for mobilization, surveying, erosion and pollution control, temporary dikes, site clearing and dewatering, etc., have been included in the unit cost for earth fill, rock, and excavation to simplify estimates.

An important long-term impact upon cultural and economic resources is that with any construction that takes place, the City or responsible government agency will become committed to operation and maintenance of the project, thus incurring continual expenses. Future structural work may be required to assure long-term success of the project.

Structural Alternative V, the 20 mile overflow channel, differs from the other alternatives in that it effects land far from the actual source of flooding. The channel would require the purchase of a minimum 150 foot right-of-way through potential and currently producing farmland. Future economic losses from removing this land from production and cost of purchasing this land must be weighed against an advantage the channel would provide: a centralized waterway for collecting surface runoff from adjacent land and transporting it to the Tanana River.

TABLE 2

COMPARISON OF STRUCTURAL ALTERNATIVES
JARVIS CREEK OVERFLOW FLOODING

ALTERNATIVE AND STRUCTURE TYPE	TECHNICAL DATA Length of Structure (FT)	MATERIAL QUANTITY Earth Fill (CY)	MATERIAL QUANTITY Riprap Rock (CY)	MATERIAL QUANTITY Excavation (CY)	MATERIAL COST Earth Fill ($)	MATERIAL COST Riprap Rock ($)	MATERIAL COST Excavation ($)	TOTAL CONSTRUCTION COST ($)	ANNUAL OPERATION AND MAINTENANCE COST ($)
ALTERNATIVE #1									
Overland dike w/o riprap	4,300	63,000	------	------	315,000	-------	-------	315,000	
Channel dike w/o riprap	21,000	227,000	------	------	908,000	-------	-------	908,000	
								1,223,000	6,000
Overland dike w/ riprap	4,300	55,000	10,000	------	275,000	500,000	-------	775,000	
Channel dike w/ riprap	21,000	227,000	71,000	------	908,000	3,550,000	-------	4,458,000	
								5,233,000	26,000
ALTERNATIVE #2									
Overland dike w/o riprap	12,200	179,000	------	------	895,000	-------	-------	895,000	
Channel dike w/o riprap	7,200	78,000	------	------	312,000	-------	-------	312,000	
								1,207,000	6,000
Overland dike w/ riprap	12,200	156,000	27,000	------	780,000	1,350,000	-------	2,130,000	
Channel dike w/ riprap	7,200	78,000	25,000	------	312,000	1,250,000	-------	1,562,000	
								3,692,000	18,000
ALTERNATIVE #3									
Overland dike w/o riprap	18,600	273,000	------	------	1,365,000	-------	-------	1,365,000	7,000
Overland dike w/ riprap	18,600	238,000	41,000	------	1,190,000	2,050,000	-------	3,240,000	16,000
ALTERNATIVE #4									
Channel dike w/o riprap	31,000	335,000	------	------	1,340,000	-------	-------	1,340,000	7,000
Channel dike w/ riprap	31,000	335,000	105,000	------	1,340,000	5,250,000	-------	6,590,000	33,000
ALTERNATIVE #5									
Overflow channel	106,000	-------	------	3,670,000	-------	--------	12,478,000	12,478,000	62,000

OPERATION AND MAINTENANCE

The continuing successful performance of any structure requires a certain amount of annual maintenance. Structures built for flood and erosion control are no different. The structural alternatives discussed may be subjected to sustained low flows and occasional high flows during flooding. In addition, structures will be subjected to the normal erosive and destructive forces of gravity, wind and temperature differential (freeze and thaw). Such forces, if left unchecked, could cause the failure of the structure, most likely occurring during periods of flooding. To prevent such a failure, a program of operation and maintenance (O&M) should be instituted at the time of construction.

An O&M program would require that the City or other responsible government agency conduct an annual inspection of the structures and that the design or responsible engineer assist with the inspections. Annual O&M inspections should be scheduled in June, prior to seasonal high stream flows on the Delta River and after spring breakup on Jarvis Creek. Needed corrective actions should then be made as soon as possible. In addition, inspections should be made immediately after any significant flood event.

Estimated costs for O&M are included in Tables 1 and 2 . Costs are rough estimates and should not be used directly for budgeting purposes. If a structure is built, a detailed O & M estimate should be made based on specifics of that structure. Then, the agency administering the O&M program should establish an O&M account for the project. Each year the estimated O&M cost should be deposited and held to accrue interest to insure adequate funds exist for future repairs as they become necessary.

TECHNICAL DATA AND RELATED MATERIAL

The technical data and related material developed to assist users of this study are provided as figures and tables in this report. Other sources containing information on erosion and flooding and maps showing extent of 100-year flood event, etc., are available to the public as follows:

1) Flood Hazard Analysis, Delta Study Area, January 1978; contact the U.S. Soil Conservation Service in either Delta Junction or Anchorage

2) Flood Insurance Study, City of Delta Junction, Alaska, March 1982; contact the State of Alaska Department of Community and Regional Affairs, Municipal and Regional Assistance Division, 949 E. 36th Street, Rm. 400, Anchorage, AK 99508.

Flood hazard and floodway maps from the above mentioned sources can be used to determine the location of points in question and their relationship to the 100-year frequency flood. Limits of flood boundaries shown are approximate and may vary on the ground somewhat from those shown on the maps. The maps may be used as guides for flood plain management decisions, general planning, and other purposes that require an understanding of location of the 100-year flood plain. The Flood Hazard Analysis should be used as the reference for locating boundaries of the 100-year frequency flood; Figure 3 of this report was copied from the hazard analysis and is included as a convenience for users of this report.

The hydraulic data presented in this report and the inundated areas shown on flood hazard maps from references listed on this page should be considered minimum estimates for the following reason: during flooding, ice and debris may partially block stream channels, or even form dams in some instances. This can cause a backup of water resulting in depths which are greater and flood inundation which is more widespread than indicated on the maps. Since the occurrence and effects of ice and debris jamming cannot be predicted, only present physical characteristics of channels were used in hydraulic calculations made for this report.

Technical data furnished herein is intended for general planning use and should not be used for structural design purposes or other technical engineering calculations under any circumstances. Before developing designs for structures, detailed engineering surveys must be completed. For more information, contact the U.S. Soil Conservation Service at either Delta Junction or Anchorage.

APPENDIX A

DESCRIPTION OF STUDY AREA

General Features

This flood plain management study covers the lower Delta River and immediate area, including Jarvis Creek. The Delta River, flowing northward, enters the Tanana River approximately 7 miles north of Delta Junction at Big Delta, and is located in hydrologic unit 19030004. The drainage areas considered here are bounded upstream by the Granite Mountains on the southeast, the Alaska Range on the south and west, and the Jack Warren moraine on the east. Elevations in the contributing drainage basin range from 1,150 feet above mean sea level on the Delta River near the Delta Junction City center to 13,832 feet at the peak of Mt. Hayes in the Alaska Range. The valley floor slopes from south to north. All streams in the area flow into the Tanana River, which flows into the Yukon River, which eventually drains into the Bering Sea.

Delta River headwaters are in the vicinity of the Tangle Lakes, near the easternmost portion of the Denali Highway. The Delta River then flows north through the Alaska Range to the Tanana River, a distance of approximately 98 miles. The Alaska Pipeline roughly parallels the entire length of the Delta River. The total Delta River drainage basin covers 1,720 square miles, or 1,100,000 acres. The river has a braided channel and is fed by at least eight named glaciers and numerous other smaller glaciers. Two of the largest contributing glaciers are Canwell and Black Rapids. At Delta Junction, the river bed is just over one mile wide. The bed is at its widest approximately 23 miles upstream from Delta Junction, measuring over 2.5 miles across.

One of the major Delta River tributaries is Jarvis Creek, which enters the Delta River about one mile south of the center of Delta Junction. The Richardson Highway crosses Jarvis Creek about one-half mile east of its confluence with the Delta River. Jarvis Creek flows north for 40 miles from Jarvis Glacier in the Granite Mountains. At least 80 percent of its 252 square mile (161,000 acre) watershed lies above the 2,000 foot elevation. Approximately 218 square miles (139,520 acres) of this watershed contribute to the spring flooding caused by aufeis blockage (see glossary) of Jarvis Creek.

Although bank erosion occurs along the Delta River, from the Richardson Highway bridge on Jarvis Creek to the mouth of the Delta River at Big Delta (approximately 11 miles), this report focuses on bank erosion along the one and a half miles of river near downtown Delta Junction. Jarvis Creek flooding is addressed from the point of aufeis blockage northward along the overflow route to the Tanana Loop area near the Tanana River, a distance of approximately 20 miles.

Climate

The study area is located in the Interior Basin of Alaska and has a continental climate. Extreme diurnal and seasonal fluctuations in temperature are normal. Temperature extremes can range from a summer high of 95 degrees Fahrenheit to a winter low of minus 63 degrees Fahrenheit.

Annual precipitation in Delta Junction averages 12 to 15 inches, while higher elevations in surrounding uplands may receive up to 50 inches of precipitation. Average snowpack depth is 17 inches in the lowlands and about 60 inches in the mountains. Fall freeze-up normally occurs in early October and spring break-up begins in April or May. Streams and lakes generally freeze to a depth of 3 to 4 feet every winter. Spring breakup releases an average of 3.2 inches of water in the Delta Junction vicinity, and often results in flooding of low-lying areas. Flooding can be especially severe if winter snow accumulations are above normal, as they were in the winter of 1984-85 when 5.2 inches of moisture was available for runoff in the spring.

Another factor which may increase runoff volume, and thus severity of flooding, is a sudden warming of temperatures that causes rapid thawing, prompting a breakup which may occur within a 2-3 day period. Naturally, flooding is even more pronounced if breakup occurs rapidly in a year with above-normal snow accumulation.

In addition, runoff is always intensified by frozen ground conditions. At breakup time, even ground which is free of permafrost is only partially thawed, with the still-frozen level typically just below the ground surface. This impervious frozen surface increases runoff by not allowing infiltration of water into the soil.

Soils

The soils of the study area and immediate vicinity are silt loams or very fine sandy loams. A general soils map (SCS 1973) shows that one soil association is present in the study area, the Salchaket-Tanana association. The Jack Warren moraine, which forms the eastern boundary of the study area, has soils belonging to the Volkmar-Nenana-Richardson association. The soils along the Delta River are mapped as Jarvis or Salchaket very fine sandy loams, which are characterized by having very fine sandy loam surfaces at least 20 inches deep (Jarvis) to 40 inches deep (Salchaket). The underlying material is a mixture of sand and gravel that extends downward at least 50 feet. Both surface and subsurface soils are highly erodible when unprotected.

Except for eroding stream banks and a few relict terraces or streambanks, most of the area is flat (0-3 percent slopes). Soil erosion is prevented in most of the study area by natural vegetation and flat slopes.

Geology

The study area is located in the "Tanana-Kuskokwim Lowlands" physiographic province described by Wahrhaftig (1965). The following description is derived from Dingman et al. (1971).

The Tanana-Kuskokwim Lowlands, including the lower portions of the Delta River drainage basin, consist of adjoining fans of glaciofluvial detritus sloping northward to the Tanana River. Bedrock lies at great depth beneath these deposits, which consist mostly of sands and gravels.

Permafrost is discontinuous and generally found at a depth of 25 feet or more. In the study area, a layer of loess covers much of the glaciofluvial deposits, except in active (unvegetated) floodplains of the Delta River and Jarvis Creek, which are the sources of this windblown material. The loess is 4 to 40 feet thick west of the Delta River, but generally less than 2 feet thick east of it.

In the area of Delta Junction, concern has been expressed that uplift (tectonic processes) to the south or west, in the Alaska Range, could be affecting river channel location. If, for example, the broad fan containing the Delta River were being uplifted on the south and/or west, the river could be forced to the north and/or east in response to gravity. If uplift, or orogeny, were at least in part responsible for bank erosion in Delta Junction, engineering works would have to resist tremendous forces initiated by uplift in addition to those set in motion by river geometry (see discussion under Hydrology). Available literature indicates that, at present, tectonic activity in the Alaska Range is probably not having an immediate effect on river alignment (Hudson and Weber 1976, Wahrhaftig et al. 1975, Stout et al. 1973, Page 1972, Richter and Matson 1971).

Hydrology and Hydraulics

Much of the meteorological and hydrological data available for the area are identified in Hydrometeorological Literature Review for the Delta - Clearwater Creek Area (Fox 1978), and summarized and cited in Hydrologic Reconnaissance of the Delta River and its Drainage Basin (Dingman et al. 1971). The latter report also provides a valuable compilation of Delta River area studies up to its date of publication.

The Delta River and Jarvis Creek can both be classified as sediment laden braided watercourses. In general, braiding occurs when stream discharge is low in relation to sediment load and the stream cannot transport enough sediment to maintain a single, deep channel. Viewed from above, braiding appears as an interwoven network of two or more roughly parallel flow channels, separated by islands or bars. The tendency of a braided stream is to widen rather than deepen its channel, accomplishing this through erosion of its often highly erodible banks. Understanding the mechanics by which Delta River and Jarvis Creek are continually forming and reshaping their channel beds will be useful to Delta Junction residents in future planning and development.

Delta River banks are over 10 feet high and the channel is a mile or more wide within the study area. Channel capacity is computed to be over 90,000 cubic feet per second (cfs), which is greater than the 500-year flow. There is no danger of overbank flooding. 100-year frequency flow is estimated to be 42,000 cfs. Jarvis Creek banks are 1 to 5 feet high and channel width within the study area varies from 1,000 feet to 1,500 feet. Overbank flooding is primarily the result of aufeis blockage. 100-year frequency flow is estimated to be 16,000 cfs.

Vegetation

The study area supports plant species typical of river valleys in Interior Alaska. In general, on flood plains and better drained soils below timber line (about 2,000 feet mean sea level elevation), stands of paper birch, aspen, and/or white spruce are the predominant vegetation.

Black spruce stands, and shrubs and other nonforest vegetation types are predominant on poorly drained soils and are often associated with sphagnum bogs. Alders, cottonwoods, and willows are common adjacent to streams and rivers. Vegetation above timber line is predominately tundra (e.g., dwarf shrublands) underlain by permafrost. Areas above 6,500 feet elevation are generally rocky and covered with snow and ice much of the year.

Much of the study area vegetation has been mapped and inventoried by the USDA SCS and Forest Service (FS) under a cooperative agreement with the Alaska Department of Natural Resources, Division of Forestry. The following discussion of study area vegetation is based primarily on SCS-FS mapping. Study area vegetation was also examined on the ground in August 1984.

Vegetation bordering the Delta River and Jarvis Creek within the study area consists primarily of forests except where disturbed by urban developments. Immediately adjacent to the confluence of Jarvis Creek and the Delta River, dominant forest plants consist of young cottonwoods, white and black spruce, and alders and willows.

Within a few hundred feet of the Jarvis Creek confluence, and extending downstream approximately 3/4 mile along the Delta River, forest vegetation consists of closed-canopy white spruce, generally 30 - 40 ft. tall and representing pole- and saw-size timber.

Understory in these white spruce stands is well-developed, and is dominated by shrubs, such as prickly rose, Labrador tea, buffalo berry and highbush cranberry, and grasses, such as horsetail and bluejoint.

Spruce stands end at the edge of the Delta Junction city center, where urban clearing has removed mature riparian vegetation. Urbanization extends about a 1/2 mile downstream along the Delta River. Downstream of the city center on the Delta River, mixed forests dominate, occasionally interspersed with small man-made clearings. Tree species in mixed forest stands include white spruce, birch, cottonwood, and aspen. Near the upstream end of the study area these trees have reached heights of 50 to 70 ft. or more.

The Fort Greely Military Reservation is the only man-made facility impacting vegetation along Jarvis Creek. Forested land has been cleared for the military field along the west bank of Jarvis Creek from one mile to three miles upstream of the Richardson Highway bridge. Cleared areas generally support indigenous and introduced "weedy" species adapted to colonizing disturbed areas. Species observed include fireweed, bluejoint grass, yarrow, chickweed, willows, and young cottonwoods.

A significant event affecting vegetation occurred recently which warrants attention. In late-May of 1987, a forest fire burned approximately 45,000 acres of land adjacent to the study area. The fire began approximately five miles to the east of Donnelly Dome and extended northward to the study area along the east bank of Jarvis Creek, to the Alaska Highway and eastward toward the Gerstle River. The western extent of the fire near the study area is shown in Figure 3 of the "Flood and Erosion History" section of this report.

Mature vegetation within this area, as described above, has most likely been burned away and will be replaced by scrub understory vegetation in the next few years as the forest begins its natural recovery cycle. Impacts on future runoff are unknown at this time.

Fish and Wildlife

Wildlife species in the study area reflect existing habitats. As described above, these habitats consist primarily of coniferous and mixed forests, shrublands, and areas disturbed by man and most recently, area altered by forest fire. Forest and shrub habitats like those found in the study area support a variety of wildlife species, including moose, black bear, snowshoe hare, beaver, northern flying and red squirrels, porcupine, voles and lemmings, least and short-tailed weasels, mink, marten, red fox, lynx, willow ptarmigan, spruce and ruffed grouse, waterfowl, raptors, woodpeckers, and a variety of songbirds. Riparian areas, in particular, generally support a disproportionately high abundance and variety of wildlife (see, for example, Flood Plain Management Studies of the Upper and Lower Tanana River and its Tributaries (SCS 1984, 1983) and Rosenberg (1983) for discussions of riparian values in Alaska).

Parts of the study area are close to or within urban areas. Wildlife use of these habitats is likely to be somewhat lower than would be expected in similar habitats elsewhere in the study area. In particular, some wide-ranging mammals, including black and brown bears, wolves, lynx, and red fox, often avoid areas of human disturbance.

American peregrine falcons represent the only Federally "Threatened or Endangered" species that may occur in the study area. These falcons are classified as "threatened" (Federal Register Vol. 49, No. 55, March 20, 1984). The U.S. Fish and Wildlife Service (USFWS) has conducted annual inventories of peregrine nests, and those of other raptors, along the upper Tanana River since 1982 (Amaral, personal communication). No peregrine nesting sites have been identified in the immediate study area, and the area does not provide suitable nesting cliffs. However, the USFWS has considered using a cliff at the confluence of the Tanana and Delta Rivers as a site from which to hack (prepare for release to the wild) fledgling peregrines. Bald eagle nests have been mapped along the Tanana River both northeast and northwest of the project area.

The Alaska Department of Fish and Game (ADF&G) regulates land-use activities within or adjacent to anadromous streams. Streams covered by ADF&G "Title 16" permits are listed in the Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes (ADF&G 1985). The Delta River is listed as river no. 334-40-11000-2490-3390 in the Catalog, in "Interior Region, Resource Management Region VI." Jarvis Creek is not listed as it is not considered to be an anadromous stream.

Fish species that use the Delta River include chum salmon and Arctic grayling. Chum salmon are known to spawn in the Delta River near its confluence with the Tanana River, but adjacent to Delta Junction, the Delta River is used primarily as a migration route. Arctic grayling have so far

been identified by the ADF&G as the only sport fish using Jarvis Creek. Grayling are known to move through the creek in spring and late fall, and occur in several Jarvis Creek tributaries.

Area Settlement and Development

Settlement in the area began about 1903 after an overland trail roughly paralleling the present day Richardson Highway was established between Valdez and Fairbanks. Rika's Roadhouse, built to serve highway travelers, was built in the same year at the ferry crossing of the Tanana River, in what is now Big Delta.

About 25 years later, in 1927, Buffalo Center was established. It was named after the free-ranging bison herd released in the area in 1925. Fort Greely construction began in 1942, the same year that the Alaska Highway was connected to the Richardson Highway. It was then that the town's name was changed to Delta Junction. Homesteading began in earnest during the early 1950's in the Clearwater area, and within 10 years, homesteads were common throughout the area.

Population data for 1984 indicate that 1,170 people reside within the city limits of Delta Junction, while 2,420 more inhabit surrounding rural areas. Fort Greely houses 2,200 military personnel and dependents. A wide range of services are provided by the more than 100 small businesses that operate in the area. Extensive farming, hunting, trapping, and fishing give the area a rural and rustic character.

The immediate study area supports a mix of small farms and residential areas. The area currently supports about 300 farms. Farming on the larger farms revolves around small grains; smaller farms concentrate on grass hay. Four land sales within the past 9 years have disposed of at least 12,000 acres of agricultural land in the study area and an additional 88,000 acres outside the study area. Several other home site and subdivision sales on state land have resulted in a variety of local land uses.

Several original homesteads have also been subdivided (two of these are situated directly in the path of Jarvis Creek floodwaters). The City has held three land sales in recent years and plans more for the future.

Agricultural development in the area has been stimulated by the State through their agricultural land sale programs. Purchasers of state agricultural land must clear their land within a specified time. Most also choose to build homes and live on their farms, even though they are not required to do so. At least 20 farms of this type exist in the study area with many others nearby.

The study area is located outside any organized borough. The Deltana Community Corporation was formed to assist with distribution of state funds for local capital improvement projects. Delta Junction itself was organized as a second class city in the 1960's. City limits border Fort Greely on the south, the Delta River on the west, and extend east,

encompassing about 9,000 acres. The confluence of Jarvis Creek and the Delta River forms the southwest corner of municipal boundaries. Neither the City nor the Deltana Community Corporation has the power to levy or collect taxes, a factor which limits certain governmental services.

NATURAL VALUES OF FLOOD PLAINS

In riverine flood plains, processes shaping life on land and in water overlap. A unique combination of conditions results. Riverine flood plains tend to be characterized by fertile soils; productive and diverse plant and animal communities; microclimates more stable and mild than those of surrounding uplands; level to gently undulating topography; and plentiful water supplies. Undeveloped flood plains reduce flood severity and protect water quality and quantity by providing areas where flood flows spread out, slow down, and infiltrate. Because moving waters create flood plains, waterborne nutrients, sediments, and living organisms are deposited on floodplains from distant sources. In addition, flood plains and the rivers they border form linear travel corridors used by fish, wildlife, and humans moving among environments within a watershed. General flood plain values are discussed in detail in a variety of reports (see for example reference (33) in bibliography). The following discussion focuses on natural values that could be provided by lands and flood plains associated with the Delta River and Jarvis Creek.

Natural values of study area lands along the Delta River stem from their closeness to the river rather than from the effects of regular overbank flows. Adjacent to Delta Junction, Delta River banks are too high to be overtopped by 100-year flood flows (although areas along the opposite bank and on Fort Greely flood). As a result, Delta Junction lands adjacent to the river are not true flood plain lands. On the other hand, part of the Jarvis Creek flood plain does occur in Delta Junction. Creek overflow frequently floods sections of the city, both as a result of storm flows or aufeis formation. Numerous channels in the Jarvis Creek flood plain indicate that overflow may follow a number of routes depending on what kind of flooding takes place.

As mentioned above, flood plains potentially provide many natural values to local communities, particularly if their hazards as building sites are recognized and they are instead managed for their natural benefits. A comparatively rich variety of wildlife species use habitats close to rivers ("riparian" habitats).

Although some species may avoid urban lands in Delta Junction, overall the variety of wildlife species in habitats along the Delta River and Jarvis Creek will be higher than in comparable habitats away from water. An obvious reason for this is that many kinds of food and shelter can be found near water. As a result, in addition to supporting animals typically found in similar upland habitats, riparian habitats also support: (a) animals that feed mostly in water while nesting or denning in trees, banks, or burrows (e.g., river otters, minks, kingfishers, bald eagles, dippers, and waterfowl), (b) species that feed largely on land plants but use water for cover (e.g., beavers and some waterfowl), and (c) species that feed both in water and on land (e.g., moose, bears, weasels, muskrats, and waterfowl). Lands along rivers are important, and often critical, in maintaining populations of riparian birds and mammals.

Along with flowing water, "structural diversity" of riparian plant communities increases the kinds of food and shelter available in many riverside habitats. Structural diversity is created when plants of many shapes and sizes, particularly trees and shrubs of different heights, grow on the same plot of land. Such varied plant layers can develop where sunlight reaches all levels of vegetation from the ground up. Along waterways, sunlight can often penetrate into bordering forests and promote well-developed shrub and herbaceous understories. The result is the multilayered pattern of plants common along many streams. Each plant layer provides food, cover, and space to different species of wildlife: thrushes and warblers occupy tree canopies, juncos and sparrows occur near the ground, woodpeckers use tree boles, red and flying squirrels nest and feed among tree branches, marten are active both on the ground and in the trees, mink, fox, and hare feed and hide among shrubs, and other species occur where appropriate conditions are found.

The variety of habitats along rivers and streams is also increased by the high "interspersion" typical of riparian areas. Interspersion is created when many different kinds of habitats or plant communities occur in a patchwork pattern, for example, where forest stands, grasslands, shrublands, and open water occur within a relatively small area. Interspersion, like structural diversity, increases the kinds of habitats present, thus providing more kinds of food and places to shelter and reproduce for more kinds of wildlife.

Forest species such as squirrels, woodpeckers, black bear, marten, and spruce grouse can be accommodated close to shrubland species such as snowshoe hare and grassland species such as voles and sparrows. In addition, many animals, such as fox, coyote, bear, raven, moose, birds of prey, etc. prefer areas of high interspersion because they provide diverse kinds of plant and animal food, as well as opportunities to feed in one kind of habitat while sheltering in another. Many "edge" species of wildlife are not found where homogeneous plant communities cover large unbroken expanses. Study area lands along Delta River and Jarvis Creek are characterized by relatively high interspersion.

Rivers and streams tend to continually renew the variety and structural diversity of plant communities found on bordering lands. Flooding, shifts of channel, abandoned oxbows, deposition of sand or gravel bars, etc. create new clearings, modify existing terrain, and initiate new stages of plant succession, all of which promote variety in and among habitats present.

Flood plains and riparian plant communities also serve important functions in enhancing aquatic habitats in adjacent waterways. Instream habitats are used by aquatic invertebrates, fish (which often feed on invertebrates), and a variety of birds and mammals that feed on fish, invertebrates, or aquatic plants. Maintaining or enhancing instream habitats depends to a large extent on maintaining appropriate vegetation along waterways; reducing streamside vegetation tends to lower the quality of related aquatic habitats.

Riparian vegetation such as is found along Delta River and Jarvis Creek enhances instream habitats in a number of ways. Water quality, for example, can be degraded if too many sediments, chemicals, or organic pollutants are carried to streams by runoff from areas upslope. Riparian vegetation (and watershed vegetation in general) reduces these inputs by slowing overland runoff. As runoff is slowed, waterborne sediments and other solids settle out and surface flows can infiltrate soils. As a result, less material is carried into waterways. The same processes occur when overbank (flood) flows move through flood plain vegetation. As they do, water velocities decline, sediments are deposited (which enrichen flood plain soils), and erosion is reduced.

For the same reasons, riparian (and upland) vegetation reduces soil erosion and bank gullying and slumping. Well-vegetated streambanks slow both surface runoff and flood flows. Slower flows have reduced capacities to pick up and carry sediments, so they are less likely to erode, gully, or undercut streamside lands. The greater the "roughness" of the vegetation through which surface or flood waters flow, the more effectively velocities are slowed and erosion is reduced.

Even poorly vegetated flood plains help reduce the severity of overbank flooding. By providing broad areas over which flood waters spread, flood plains increase area wetted and decrease water depth, both of which reduce water velocities and decrease downstream flooding. Depressions in flood plain terrain, such as abandoned channels, oxbow lakes, potholes, and wetlands, help to trap, retard, and "soak up" floodwaters, reducing their velocity and depth. Slowing down flows also helps whatever vegetation is present to withstand flooding. Entrapment of water in depressions provides refuges where organisms are sheltered from strong currents.

Riparian vegetation also benefits instream habitats by contributing organic litter (such as leaf fall) to aquatic food chains and by providing sources of large organic debris such as fallen trees. Large organic debris falling into streams creates aquatic "microhabitats." Aquatic invertebrates, fish, birds, and mammals can find shelter among fallen stems and branches, as well as sites with reduced flow velocities. Many species, particularly fish and invertebrates, use such microsites for resting, feeding, or laying eggs. Too much debris, however, can choke streams and block passage of aquatic animals.

Streamside vegetation also moderates and stabilizes water temperatures and riparian microclimates. Such vegetation filters sunlight, reduces radiation and convective heat loss from water and land surfaces, and reduces local wind speeds. As a result, fish and wildlife using streams or riparian lands with dense vegetation often find comparatively mild and stable microclimates.

Groundwater recharge is also enhanced where surface and overbank flows are slowed by vegetation or topographic depressions. When filled by flood flows, depressions found in flood plains permit surface waters to percolate down to groundwater reservoirs (aquifers) and replenish them.

During dry seasons, underground water moves from aquifers into streams and lakes whose water levels have dropped below the water table. Such groundwater outflow may be the primary source of water in some lakes and streams during low-flow periods. Many aquifers providing important sources of water to human settlements are recharged primarily from nearby flood plains.

Lands along rivers have traditionally provided sites for a variety of human activities. Since prehistoric times, human cultures have focused their energies and settlements along waterways (despite the frequent flooding of settlements) because these areas tended to concentrate and funnel fish and wildlife and provided relatively easy travel routes -- with boats in summer, sleds (and now also snowmachines and 3-wheelers) in winter. The popularity of fishing, trapping, hunting, rafting, kayaking, canoeing, dog mushing, hiking, camping, and wildlife viewing on rivers or adjacent lands continues to grow. Riparian lands can readily be enhanced to promote fish, wildlife, recreation, and aesthetics. If so managed, they can become tremendously valuable to local communities in terms of the food resources and kinds of outdoor recreation they provide. Lands along Delta Junction and Jarvis Creek have high potential for providing most of these natural values.

APPENDIX B

ENVIRONMENTAL ASSESSMENT

ENVIRONMENTAL ASSESSMENT

General

Environmental impacts of flood and erosion control alternatives presented in this report for both the Delta River and Jarvis Creek project areas are discussed in separate sections beginning on the next page. The following recommendations pertain to both project areas and should be adhered to, to minimize negative environmental effects to wildlife:

1. Consult with ADF&G throughout project design and construction to ensure that wildlife impacts are adequately identified and addressed.

2. Avoid compacting soil when practical, reseed cleared areas as soon as possible with appropriate species (refer to the Revegetative Guide for Alaska-RDC 1983), design reclamation and reseeding activities to enhance wildlife habitats.

3. Create wildlife cover such as brush piles.

4. Minimize construction of roads.

5. Minimize disturbances to riparian vegetation and to mature plant communities; in particular, avoid cutting mature trees and damaging existing streambank vegetation.

6. When moving equipment and material into the river channel, limit access points into and out of the river to as few sites as possible; have access points approved by the ADF&G; wherever possible, select locations where mature vegetation (particularly trees) will not be disturbed.

7. Minimize duration of construction activities, schedule construction activities to minimize disturbances to breeding wildlife.

The following applies to both project areas and should be adhered to to minimize negative environmental effects on fisheries:

1. Consult with ADF&G throughout project design and construction to ensure that fisheries effects are adequately reviewed, monitored, and managed.

2. Design borrow pit excavations with habitat enhancement in mind (contact ADF&G for assistance with design).

3. Minimize disturbance to stream banks and riparian vegetation.

4. Ensure that construction activities do not create any barriers to fish movements.

5. Construct a temporary dike to restrict movements of sediments into flowing segments of stream or river channels.

6. Limit access points into and out of stream or river channels to as few sites as possible; have these access points approved by the ADF&G; cross perpendicular to flowing channels; wherever possible, select access sites where mature vegetation (particularly trees) will not be disturbed when entering and leaving channels.

7. Schedule construction activities when salmon are not using Delta River spawning areas and grayling are not using Jarvis Creek.

8. Reseed areas cleared during construction to prevent erosion of sediments into stream or river channels.

Delta River

The following provides information on environmental impacts associated with controlling Delta River bank erosion, as proposed in this report:

a) wildlife

Overall direct environmental impacts of installing Delta River erosion control structures are neutral or positive. Wildlife, particularly animals commonly found along rivers, will be disturbed by construction and possibly also by the presence of permanent structures. However, construction impacts will be short-term and localized, and large acreages of comparable habitats exist near the project area and should remain undisturbed into the future. Bison, which use the Delta River streambed upstream of the study area as calving grounds and for summer range will not be adversely impacted. Animals most likely to be affected by construction activities are those that require later seral plant communities for food and/or cover (e.g., mink, beaver); are displaced from local home ranges (e.g., muskrat, mink, shrews, hares); are particularly sensitive to human activities (e.g., lynx); or are already under stress (e.g., animals rearing young or leaving parental protection to fend for themselves). Construction involves a limited area: along the Delta River, an area approximately one and a half miles long and approximately 500 feet wide.

Though they do not use the project area, peregrine falcons could theoretically be impacted by excavation of construction materials from nearby borrow sites. Two possible borrow sites have been suggested as sources of materials if riprap armoring is to be used. One site adjoins Donnelly Dome, the other is at Big Delta near the confluence of the Tanana and Delta Rivers. Both sites provide potential peregrine nesting habitat, and the USFWS has considered the latter site as a potential peregrine "hacking" cliff (site from which to reintroduce hand-reared peregrines to the wild).

The USFWS has recommended that, if possible, the Donnelly Dome borrow site be used, but notes that with scheduling restrictions and monitoring of spring peregrine activity, the Big Delta site could also be used without detrimental impacts to peregrines (Amaral, personal communication). If peregrines are observed using

study areas during construction, the USFWS should be notified and site work should cease until the USFWS has approved resumption of activities.

Raptors (birds of prey) are generally long-lived birds that often occur at relatively low population densities. Some raptors, such as sharp-shinned hawks, red-tailed hawks, great gray owls, great horned owls, etc. may nest in the project area. Nesting birds are likely to be temporarily driven from the project area by construction activities. To protect these birds where possible, nests discovered during construction should be noted and avoided.

Indirect project impacts to wildlife are difficult to evaluate at this time. If, for example, Delta River bank stabilization encourages further urban development and land clearing along the Delta River, the project will have long-term negative effects on local riparian habitats and wildlife species. In addition, species that avoid urban areas will be eliminated from zones of urban expansion and replaced by species adapted to human settlements and disturbed environments. The extent and precise nature of the effects cannot be predicted at this time.

The possibility that wildlife may negatively affect projects should also be noted. Burrowing animals may weaken dikes. Arctic ground squirrels, for example, appear to be attracted to areas of soil disturbance (Melchior and Iwen 1965) and may colonize dikes. They have already colonized fill material deposited behind Diehl's store along the Delta River.

The Delta River is considered by the Alaska Department of Fish and Game (ADF&G) to be and anadromous river. Two important fish species have been identified by ADF&G as using the Delta River near Delta Junction: chum salmon and Arctic grayling.

No critical fish habitats are known to occur in the project area. Construction of engineering works will pose no significant threat to local fish species and in fact, fish habitat should be enhanced by works which stop erosion (less sediment entering the water). Guidelines presented at the beginning of this section should be followed strictly.

b) <u>vegetation</u>

No unique or endangered plant species or communities are known to exist in the study area. In the short-term, less than 10 acres of vegetation will be disturbed or eliminated during construction of engineering works. These areas will be revegetated according to specifications in the <u>Revegetative Guide for Alaska</u> (RDC 1983). The extent of damage to local plant communities will depend on which flood control structures are selected and how they are constructed. In the long-term, installation of flood-control structures will eliminate or slow the destruction of plant communities currently caused by collapse of banks undercut by the

Delta River. In both cases, impacts to plant communities are small-scale and local in nature. In addition, plant communities that would be affected are widespread and common in surrounding areas (beyond Delta Junction urban and agricultural developments).

Indirect impacts of engineering works on local plant communities will depend on how these works affect the development of Delta Junction. Either with or without engineering works, urban growth may eliminate existing riparian plant communities unless local residents specifically decide to maintain a vegetated greenbelt on the banks of the Delta River. Without engineering works, an undeterminable amount of riparian vegetation will be eliminated by Delta River bank erosion.

c) <u>wetlands</u>

Most of the land located within the the study area can be classified as riparian and is considered to be regulatory wetland. Prior to any construction within the Delta River channel and riverbank, the Army Corps of Engineers must be contacted and a Permit No. 404 issued.

Through issuing this permit, the Corps of Engineers is able to protect valuable wetland areas by regulating, limiting or denying construction within wetland areas. It is not anticipated that there will be a problem in obtaining the No. 404 permit: work has been done previously within the project area in controlling bank erosion (as described in this report), and as a part of the development of the City of Delta Junction.

d) <u>aesthetics</u>

Construction activities will cause local alterations in natural riverfront terrain. Revegetation will gradually reduce visual impacts of projects; several years will be required for engineering works to blend into their surroundings.

Negative aesthetic impacts can be reduced by integrating engineering works as much as possible into natural hydrologic, terrain, and vegetation features. In addition, revegetating and landscaping disturbed shorelines and installed dikes or groins while maintaining as much project site vegetation as possible can ameliorate effects of disturbances. Because engineering works would be located in an area readily seen and easily accessible to the public, visual impacts could affect many individuals, both residents and tourists. Bank stabilization will provide opportunities for land owners to landscape or remove debris presently being used for interim erosion control.

e) <u>air quality and noise</u>

Undeterminable amounts of dust and exhaust fumes will be generated during project construction. These will negatively affect air quality throughout the constructive period.

Air quality impacts are considered insignificant, both because all such impacts will cease after construction is completed and because these impacts will be short-term and localized. Actual impacts to air quality should be slight due to quick dispersion by winds common to the area.

Construction activities, particularly the use of heavy machinery, will generate considerable noise in the immediate project area. Noise impacts, like air quality impacts, will be short-term and localized, and are not considered significant.

f) <u>recreation</u>

Currently, recreational uses of the project area are limited. The affected portion of the Delta River is not used for boating. Adjacent riverbanks are privately owned and are not used for fishing or other recreational activities such as picnicking or camping.

Good opportunities exist to promote recreation in the project area for both tourists and residents. The project area is in the heart of Delta Junction, close to retail facilities at which tourists commonly stop while traveling the Alaska and Richardson Highways. As a result, development of riverside recreational facilities could easily serve large numbers of tourists and encourage more travelers to stop and spend time in Delta Junction. Because the project area is centrally located in town, recreational sites developed there would also be conveniently located for residents.

In order to encourage recreational uses of the area by both tourists and the local community, Delta Junction planners may wish to consider developing a riverside recreational greenbelt in concert with constructing engineering works. Picnic tables, fire pits, etc. could be installed along the river. Establishing a riverine greenbelt would also benefit local wildlife and improve local aesthetic conditions.

g) <u>land use</u>

Direct land use impacts of proposed projects are relatively easy to assess. Installing Delta River bank stabilization projects will protect from erosion approximately 500 acres of land over the next 100 years. At the present time, this land supports 50+ commercial and residential structures. Also protected would be approximately 1.5 miles of state owned highway, plus several local roads.

Long-term land uses in areas stabilized by proposed projects are likely to be significantly affected by engineering works, but these indirect impacts cannot be evaluated at this time. Once protected from further river bank erosion, lands are likely to be developed more rapidly and/or extensively than without protection.

Installation of engineering works may lead to land-use developments that would not have occurred otherwise. Use of previously damage-prone lands should be guided by the fact that they will be located in potentially hazardous areas even after engineering works reduce potential hazards.

h) cultural/archeological resources

SCS policy is to protect historic properties in their original place to the fullest extent practicable. If adverse effects on historic properties cannot be avoided, SCS will develop feasible mitigation measures in consultation with participants, State historic preservation officers, and the Advisory Council on Historic Preservation as appropriate to eliminate or lessen adverse effects before construction or assistance completion (SCS 420 General Manual 401.2).

Two sites of cultural/paleontological interest have been identified in the project area (Alaska Heritage Resources Survey 1985):

1. XBD-087: This site consists of a hearth (fireplace) in a gravel pit on the northern side of Delta Junction (NE 1/4 of NW 1/4 of Section 14, Township 10S, Range 10E). The status of this hearth is unknown, but it is presumed to have been disturbed by gravel removal operations since its discovery in the 1970's.

2. XBD-005: The City of Delta Junction is itself listed under this site number.

Proposed engineering works do not appear to threaten these sites (Rigg personal communication), but the Division of Geological and Geophysical Survey, Alaska Department of Natural Resources, stipulates that, should cultural or paleontological resources be discovered as a result of this activity, work which would disturb such resources be stopped and that the State Historic Preservation Office be contacted immediately.

i) commitment of resources

One potentially significant impact of engineering works is their effect on long-term commitment of state, national, and local resources. By constructing bank stabilization works, the City of Delta Junction and other project participants commit themselves long-term to managing Delta River bank erosion with structural measures. In general, once structural measures are constructed or installed, their maintenance, repair, and eventual replacement become imperative, particularly as land values rise in previously threatened areas that are now perceived as "safe." Increased land values of "erosion-protected" riverfront property and the potential costs of additional damage, increase incentives to maintain and

extend engineering works. Land development resulting from proposed projects is likely to obligate the City of Delta Junction, the Army, and other involved agencies to long-term commitments of resources for structural erosion control.

Jarvis Creek

The alternatives presented for alleviating overflow flooding on Jarvis Creek would impact the local environment in different ways. Basically, construction would consist of: 1) clearing of forested land, reshaping of stream bank, and excavation within the stream bed for alternatives I and II, 2) clearing of forested land and excavation within the stream bed for alternative III, 3) excavation within the stream bed and some reshaping of stream bank for alternative IV, and 4) clearing of land and excavation within low areas for alternative V. In addition, if riprap is used, mining of rock at one of two potential quarry sites would occur. Though any of the proposed structural alternatives will have some environmental impact, effects are considered to be insignificant.

The following provides supplemental information on environmental impacts associated with controlling Jarvis Creek overflow flooding, as proposed in this report:

a) wildlife

As discussed under Delta River impacts, impacts to wildlife from any of the proposed Jarvis Creek structural alternatives will be short-term and localized, with large acreages of comparable habitats existing nearby that should remain undisturbed into the future. Animals most likely to be affected by construction activities are those commonly found along streams or rivers, especially those that require later seral plant communities for food and/or cover (e.g., mink, beaver); are displaced from local home ranges (e.g., muskrat, mink, shrews, hares); are particularly sensitive to human activities (e.g., lynx); or are already under stress (e.g., animals rearing young or leaving parental protection to fend for themselves). Depending on the selected alternative, construction could last from three months to more than a year. Area disturbed by construction varies greatly with selected construction alternative.

Though they do not use the project area, peregrine falcons could theoretically be impacted by excavation of construction materials from nearby borrow sites. Two possible borrow sites have been suggested as sources of material if riprap armoring is to be used. One site adjoins Donnelly Dome, the other is at Big Delta near the confluence of the Tanana and Delta Rivers. Both sites provide potential peregrine nesting habitat, and the USFWS has considered the latter site as a potential peregrine "hacking" cliff (site from which to reintroduce hand-reared peregrines to the wild).

The USFWS has recommended that, if possible, the Donnelly Dome borrow site be used, but notes that with scheduling restrictions and monitoring of spring peregrine activity, the Big Delta site could also be used without detrimental impacts to peregrines (Amaral, personal communication). If peregrines are observed using study areas during construction, the USFWS should be notified and site work should cease until the USFWS has approved resumption of activities.

Raptors (birds of prey) are generally long-lived birds that often occur at relatively low population densities. Some raptors, such as sharp-shinned hawks, red-tailed hawks, great gray owls, great horned owls, etc. may nest in project areas. Nesting birds are likely to be temporarily driven from project areas by construction activities. To protect these birds where possible, nests discovered prior to and during construction should be noted and avoided.

Indirect project impacts to wildlife are difficult to evaluate at this time. If structures that control Jarvis Creek flooding lead to increased developments in newly protected areas, they will indirectly affect habitats and wildlife populations in those areas. In addition, species that avoid urban areas will be eliminated from zones of urban expansion and replaced by species adapted to human settlements and disturbed environments. The extent and precise nature of these effects cannot be predicted at this time.

The possibility that wildlife may negatively affect projects should also be noted. Burrowing animals may weaken dikes. Arctic ground squirrels, for example, appear to be attracted to areas of soil disturbance (Melchior and Iwen 1965) and may colonize dikes.

Jarvis Creek is not considered by ADF&G to be an anadromous stream. Arctic grayling are the only fish reported by ADF&G to use Jarvis Creek. The degree of short-term impact on grayling will depend on the level of disturbance to Jarvis Creek caused by removal of channel material for dike and possibly gabion construction. Guidelines presented at the beginning of this section should be followed closely to minimize short-term impacts to grayling. There will be no long-term impact to the grayling population, in fact, fish habitat should be enhanced by works which stop erosion as less sediment will be entering the water.

b) <u>vegetation</u>

No unique or endangered plants species or communities are known to exist in the study area. In the short-term, the amount of land cleared of vegetation during project construction is greatly dependent on the construction alternative selected. Cleared areas will be revegetated according to specifications in the <u>Revegetative</u>

Guide for Alaska (RDC 1983). In the long-term, impacts to vegetation along Jarvis Creek will depend on type of equipment used for dike maintenance and on frequency and kind of maintenance activities.

c) wetlands

Portions of the land within the project area, and land affected by overflow flooding, is considered to be regulatory wetland. Prior to any construction in wetland areas, the Army Corps of Engineers must be contacted and a Permit No. 404 issued. Through issuing this permit, the Corps of Engineers is able to protect valuable wetlands by regulating, limiting or denying construction within wetland areas.

It is not anticipated that there will be a problem in obtaining the No. 404 permit: work should be of minor consequence to waterfowl and wildlife within the area, and affected wetlands are not considered to be (in the opinion of the authors of this report) of prime value as wetlands.

d) aesthetics

Dike construction will locally degrade the visual setting near Jarvis Creek, though impacts can be lessened by use of construction materials which are natural and blend with local surroundings. Revegetation will gradually reduce visual impacts of the project, but several years will be required for the dike and clearing to begin blending into surrounding environments. Even then, the dike's straight, linear shape will contrast with the natural landscape, although local topographic variations may soften this contrast to some extent. Because the dike will be located on army land not generally accessible to the public, aesthetic concerns may be considered insignificant. Establishment of rock and brush piles, maintenance of as much project site vegetation as possible, and careful design of revegetation can do much to ameliorate the appearance of the dike.

e) air quality and noise

Undeterminable amounts of dust and exhaust fumes will be generated during project construction. These will negatively affect air quality throughout the construction period. Air quality impacts are considered insignificant, both because all such impacts will cease after construction is completed and because these impacts will be short-term and localized. Actual impacts to air quality should be slight due to quick dispersion by winds common to the area.

Construction activities, particularly the use of heavy machinery, will generate considerable noise in the immediate project area. Noise impacts, like air quality impacts, will be short-term and localized, and are not considered significant.

f) recreation

No recreational opportunities exist within the project area as land is part of the Fort Greely Military Reservation.

g) land use

Direct land use impacts of proposed projects are relatively easy to assess. Installing dikes in the Jarvis Creek area will reduce flooding on approximately 8-10,000 acres, 4000 acres of which are agricultural lands representing 13 farms.

Long-term land uses in areas flood-proofed by proposed projects are likely to be significantly affected by engineering works, but these indirect impacts cannot be evaluated at this time. Once protected from further aufeis flooding, lands are likely to be developed more rapidly and/or extensively than without protection. Installation of engineering works may lead to land-use developments that would not have occurred otherwise. Use of previously damage-prone lands should be guided by the fact that they will still be located in potentially hazardous areas even after engineering works reduce potential hazards.

h) cultural/archeological resources

SCS policy is to protect historic properties in their original place to the fullest extent practicable. If adverse effects on historic properties cannot be avoided, SCS will develop feasible mitigation measures in consultation with participants, State historic preservation officers, and the Advisory Council on Historic Preservation as appropriate to eliminate or lessen adverse effects before construction or assistance completion (SCS 420 General Manual 401.2).

The project area was surveyed by DGGS for archeological resources in 1975 and was designated a "low probability area" in terms of containing such resources. Although no archeological sites are known to occur in the area, a hearth (fireplace) was exposed in the 1970's by erosion of Jarvis Creek's north streambank near the confluence with the Delta River (Rigg personal comm.). This hearth was designated site XBD-091 in the Alaska Heritage Resources Survey.

The State Division of Geological and Geophysical Survey stipulates that should cultural or paleontological resources be discovered as a result of this activity, work which would disturb such resources be stopped and that the State Historic Preservation Office be contacted immediately.

i) commitment of resources

One potentially significant impact of engineering works is their effect on long-term commitment of state, national, and local resources. Once a flood control dike or channel has been

constructed along Jarvis Creek, the Army or some other entity will be obligated to maintain it. In general, once structural measures are constructed or installed, their maintenance, repair, and eventual replacement become imperative, particularly as land values rise in previously threatened areas that are now perceived as "safe." Increased land values of "flood-proofed" property, and hence potential costs of damage, increase incentives to maintain and extend engineering works. Land development resulting from proposed projects is likely to obligate the City of Delta Junction, the Army, and other involved agencies to long-term commitments of resources for structural erosion control.

APPENDIX C

GLOSSARY

ANADROMOUS STREAM - Used by fish from the sea for breeding.

AUFEIS - A German word meaning "upon ice," this is the formation of ice in a river channel. Occurs when water from a constant, unblocked source (such as a spring) continually flows over previously formed ice and freezes. Aufeis is most likely to occur where channel slope flattens causing flow velocity to decrease, thereby lessening the cutting power of water.

BREAK UP - A period in the spring when the winter's snow and ice accumulations melt and runoff occurs.

CHANNEL - A natural or man-made open conduit that periodically or continuously conveys water. River, creek, stream, branch, and tributary are terms used to describe natural channels.

DISCHARGE - Rate of flow at a given instant in terms of volume per unit of time, e.g. cubic feet per second (cfs).

DRAINAGE AREA - The land area, measured in a horizontal plane, which contributes flow to a body of water at a certain location. See watershed.

EROSION - Detachment and movement of soils or rock fragments by water, wind, ice or gravity.

FLOOD - Overflow or inundation of normally dry lands from a stream or other body of water, measured by either stage or discharge.

FLOOD FREQUENCY - The predicted average interval of time between floods, generally expressed in years. Following are examples:

10-year flood or 10-year frequency flood. Measured by stage or discharge, the flood which will be matched or exceeded on an average once in 10 years, and which would have a 10 percent chance of being equaled or exceeded in any given year;

50-year flood ... two percent chance ... in any given year.

100-year flood ... one percent chance ... in any given year.

500-year flood ... two-tenths percent chance ... in any given year.

FLOOD HAZARD - A general term meaning the risk to life or damage to property from: overflow of river or stream channels, extraordinary waves or tides occurring on lake or estuary shores, floodflow in intermittent or normally dry streams, floods on tributary streams, floods caused by accumulated debris or ice in rivers, or other similar events.

FLOOD PLAIN OR FLOOD PRONE AREA - Land area that is subject to flooding which lies adjacent to a channel or body of water.

FLOOD PLAIN MANAGEMENT - The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works, and land use and control measures.

FREEZE UP - Occurs in the fall when continual subfreezing temperatures result in ground which stays frozen until spring break up.

GABION - A wire basket filled with small to medium size rock (often excavated river bed cobbles) and connected to other similar baskets. Used for flood and erosion control.

GLACIOFLUVIAL DETRITUS - Material produced by the disintegration and weathering of rock that has been moved from its site of orgin by streams flowing from glaciers.

GREENBELT AREA - A strip of land kept in a natural or relatively undeveloped state, or in agricultural use, established around urban developments or along the flood plain of a stream or body of water.

HEADWATER - 1) The source of a stream, or 2) the water upstream from a structure or point on a stream.

LOESS - A homogeneous, nonstratified deposit consisting mainly of silt with some small amounts of very fine sand and/or clay.

OROGENY - The process of building mountains, particularly by folding and thrusting of earth's crust.

PERMAFROST - Pereniallyfrozen ground.

RIPRAP - Large angular rock placed on an earthen embankment or in a drainage channel for erosion control.

RUNOFF - The portion of precipitation or snowmelt which is discharged from a drainage area. Types include surface runoff, ground water runoff and seepage.

SEDIMENT - Mineral and organic material transported by air, water, gravity or ice.

STAGE - Elevation of a water surface above a chosen datum plane (often an established low water plane).

STREAM - Any natural channel or depression through which water flows continuously, seasonally or intermittently.

STRUCTURE - Something constructed by mankind that requires a more or less permanent location on or in the ground, including but not limited to bridges, buildings, canals, dams, ditches, diversions, irrigation systems, pumps, pipelines, railroads, roads, sewage disposal systems, underground conduits, water supply systems, boat docks, and wells.

TECTONIC PROCESSES - Processes causing deformation of earth's crust.

WATERSHED - A land area comprised of one or more drainage areas and characterized by certain plant and animal habitats.

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CONVERSION TABLE

Multiply inch-pound units	by	to obtain SI* (metric) units
cubic feet per second (ft^3/s)	0.0283	cubic meters per second (m^3/s)
cubic feet per second per square mile ¼(ft^3/s)/mi^2½	0.0109	cubic meters per second per square kilometer ¼(m^3/s)/km^2½
square miles (mi^2)	2.589	square kilometers (km^2)
acres	0.405	hectares
feet (ft.)	0.3048	meters (m)
inches (in.)	2.540	centimeters (cm)
degrees Fahrenheit (degrees F)	5/9 (degrees F-32)	degrees Celsius (degrees C)

*Systems Internationale

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